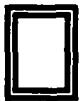


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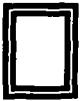
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# REMOVAL ACTION DESIGN REPORT

BELOIT CORPORATION - BLACKHAWK FACILITY  
ROCKTON, ILLINOIS

APRIL 1996

---

*PREPARED FOR:*  
**BELOIT CORPORATION**  
*BELOIT, WISCONSIN*  
•••  
*PREPARED BY:*  
**MONTGOMERY WATSON**  
*MADISON, WISCONSIN*

PROJECT NO. 3856.0080



**MONTGOMERY WATSON**



MONTGOMERY WATSON

October 17, 1995

Eric Runkel  
Illinois Environmental Protection Agency  
2200 Churchill Drive  
Springfield, Illinois 62794

Re: Removal Action Design Report Addendum

Dear Mr. Runkel:

This letter responds to your September 7, 1995 review of the Removal Action Design Report for Beloit Corporation's Blackhawk facility. The changes to this report are minor and can be done through this addendum. In addition, this is not a formal document required in the CERCLA process. Therefore, we do not plan to modify and submit the entire revised report. The addendum to specific pages and maps are enclosed with this letter.

The following comments respond to the specific comments made in your letter and follow the same numbering sequence.

1. The clean up standards referred to in the text is clarified in the text.
2. through 7. The text is modified as requested.
8. A discussion of the sensitivity analysis is included in revised pages of Appendix A.
9. The current plan is to conduct the pilot borings prior to mobilizing the drill rig for constructing the extraction wells. This will leave sufficient time for conducting lab grain size analyses.
10. The text has been revised to provide additional explanations. The filter pack material proposed (0.7 mm to 0.8 mm) for Extraction Wells EW02, EW03, and EW04 should be combined with a 0.030 inch slot or 0.035 inch slot screen depending on the specific filter pack curve provided by the manufacturer. Grain size results from the pilot borings will provide a much better estimate of the best filter pack/slot size combination. The selection of a 0.050 inch slot size for the well screen of EW01 was based on 60% of the formation materials near the borehole passing through the screen and pumped from the well during development. As, stated above, grain size results from the pilot borings will provide a much better estimate of the best slot size selection for well EW01.

11. A table (Table C-1) has been included to describe the methods for estimating the stripper's influent VOC concentrations. The range of flow rates used in the treatment system design is based on preliminary estimates of the flow rate obtainable from each well.
12. The text is modified as requested.
13. The text is modified as requested.
14. Monitoring water levels every other month for 12 months was proposed because it will take several months (approximately 6 months) to reach steady state conditions. Changes in water levels due to pumping are expected to occur relatively slowly because of the large cone of depression that will be created. Therefore, collecting water levels every month is not necessary.
15. Preparing monthly status reports will have very little to report, without water levels. Therefore, we propose to submit progress reports every other month.
16. The text is modified as requested.
17. The text is modified as requested, except that there are no special analytical services being used. Beloit Corporation is not planning on any air monitoring because the very low concentrations expected in the air discharge can be more accurately measured as a difference between the influent and effluent monitoring.
18. All of the existing wells are shown on existing drawings and proposed wells are specified with coordinates or specific locations. Therefore, a revised map was not presented. Monitoring staff gages 8, 9 and 10 are not planned to be monitored routinely because the river stage levels are easily estimated between existing staff gages 6 and 7 and staff gages 8, 9, and 10 have difficult access.
19. A map showing the model grid, the BCP and the constant head cell is included as Figure 1B.
20. The typo on Figure 2 has been corrected and additional clarification is provided in Appendix A.
21. References for river leakage factors have been provided in Appendix A. The river leakage factors were not included in the sensitivity analysis because the drawdown did not significantly affect the head below the river. Therefore, the river leakage values would not significantly affect the simulation of pumping at the selected locations.
22. Additional clarification has been provided in Appendix A.

23. A range of pumping rates have already been presented to indicate the potential effects of pumping at higher and lower rates. A mass balance for the model has been included in Appendix A.

We trust these responses and revisions will satisfy your needs at this point in time. We look forward to working with you to install this removal action this fall.

If you have any questions regarding this addendum to the Removal Action Design Report, please contact us.

Sincerely,



Kenneth J. Quinn  
Principal Hydrogeologist

Enclosure: Revised pages of the Removal Action Design Report

cc: Kevin J. Domack - Harnischfeger Industries, Inc. (w/encl.)  
Frederick Mueller - Johnson & Bell (w/encl.)  
Dennis L. Hays - Beloit Corporation (w/o encl.)  
Russ Hebb - Beloit Corporation (w/encl.)  
Doug McLeish - Beloit Corporation (w/encl.)  
Terry Ayres - Illinois Environmental Protection Agency (w/o encl.)  
Paul Jagiello - Illinois Environmental Protection Agency (w/o encl.)  
Eileen Furey - U.S. Environmental Protection Agency (w/o encl.)  
Mary Tierney - U.S. Environmental Protection Agency (w/o encl.)  
Matthew J. Dunn - Attorney General's Office (w/o encl.)  
Susan Horn - Attorney General's Office (w/o encl.)

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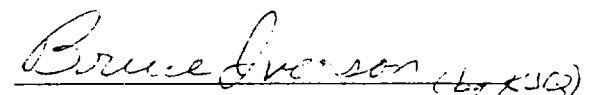
# REMOVAL ACTION DESIGN REPORT

BELOIT CORPORATION - BLACKHAWK FACILITY  
ROCKTON, ILLINOIS

APRIL 1996



Kenneth J. Quinn  
Kenneth J. Quinn  
Principal Hydrogeologist



Bruce A. Iverson (b7c)(5)  
Bruce A. Iverson  
Supervising Engineer

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# **REMOVAL ACTION DESIGN REPORT**

## **BELOIT CORPORATION -**

## **BLACKHAWK FACILITY**

## **ROCKTON, ILLINOIS**

On behalf of Beloit Corporation, Montgomery Watson is submitting this Removal Action Design Report. This report provides information requested in the Illinois Environmental Protection Agency (IEPA) letter dated June 6, 1995, as discussed during a meeting on June 16, 1995, and at a meeting on March 19, 1996. This Removal Action Design Report is associated with the source control removal action (RA) presented in the Engineering Evaluation/Cost Analysis (EE/CA) dated July 7, 1995.

For convenience in reviewing, this report has been organized into the following sections which reflects the information requested on pages 4 and 5 of the IEPA letter dated June 6, 1995, including:

1. Objectives
2. Basis for Design
3. Extraction Well Placement
4. Well Construction
5. Treatment, Collection, and Distribution Systems
6. Monitoring Plan
7. Schedule
8. Criteria for Adjusting System

### **SECTION 1: OBJECTIVES**

As discussed in Montgomery Watson's EE/CA Source Control Removal Action report dated July 7, 1995, the principal objectives of this source control removal action are to:

- Limit the potential for migration of volatile organic compounds (VOCs) in groundwater on the Removal Action Site (RA Site) through installation of a groundwater containment system.

- Initiate removal of VOCs from the groundwater at the source area (in the vicinity of the erection bay and well W23).

This action is being taken as an interim action, during completion of the Remedial Investigation/Feasibility Study (RI/FS) and final remedy selection process through the Record of Decision (ROD). Therefore, no final groundwater cleanup standards are being proposed for determining how clean the in situ groundwater must be before closing down the pump and treat system. Discharge standards for the treated groundwater will be established through the NPDES permit process.

The objective of the extraction system is to establish a capture zone on the RA Site that limits the potential for movement of VOCs in groundwater off the RA Site. Therefore, the capture zone should extend to the edges of the RA Site. As a practical matter, the capture zone will extend somewhat beyond.

As discussed in Section 7 of the EE/CA, the major elements of the recommended source control removal action include:

- Groundwater extraction.
- Groundwater treatment with air stripping.
- Discharge to the Rock River.
- Monitoring.

Groundwater extraction would involve pumping groundwater so as to reduce the migration of VOCs in groundwater and to initiate removal of VOCs from the groundwater at the source area, as well as other on-site areas where groundwater samples have exceeded MCLs. A preliminary estimate is that these objectives can be met with four wells. The groundwater extraction rate from each well has been refined from the EE/CA, through the use of a groundwater flow model presented in this report (see Section 2). The flow rate is estimated to be a total of approximately 140 gpm, with the potential of up to 200 gpm.

Extracted groundwater would be conveyed by underground piping to a treatment building. Groundwater treatment would involve physical treatment by air stripping. In an air stripper, the surface area of a film of water is maximized while air is blown across it, counterflow to the water flow. VOCs at the air/water interface are volatilized, removing them from the water. The strippability of a compound (e.g., PCE) is a function of its volatility and solubility. The easiest compounds to strip are highly volatile and slightly soluble. The physical/chemical parameters of PCE, TCE, 1,1-DCE, and 1,2-DCE, the principal VOCs present, are such that they are readily strippable. A summary of the physical and chemical properties of these compounds was provided in the EE/CA.

Design of the air stripper would allow for changes in the flow rate and concentration within a range expected for this system. This would allow for increasing or decreasing the flow rate due to variances in the number or capacity of the wells, and changes in VOC concentrations. Discharge of treated groundwater would involve conveying it by underground piping for discharge to the Rock River.

Anticipated air emissions are expected to be below discharge standards (based on air emission rates and concentrations of VOCs), therefore, no treatment would be needed and air discharge would occur directly to the atmosphere.

Monitoring would be used to assess the following: 1) groundwater treatment system efficiency; 2) treatment system influent and effluent water quality; 3) site groundwater quality; and 4) migration control system effectiveness. Details of the monitoring plan are discussed in Sections 5 and 6, including:

- Sampling of treatment system influent
- Air emission calculations
- Sampling of treated water discharged to the Rock River
- Groundwater monitoring at wells

The results and interpretation of the monitoring results will be used to evaluate the removal action.

## SECTION 2: BASIS FOR DESIGN

The primary basis for the design of this removal action are the results of Technical Memoranda No. 1 and No. 2, and Montgomery Watson's experience in the design and operation of similar systems. In addition, a preliminary groundwater flow model was developed to simulate potential pumping rates and capture zones for proposed extraction wells. The model consists of a steady-state, two dimensional, finite difference, groundwater flow model. The software used was FLOWPATH (version 5.1), developed by Waterloo Hydrogeologic Software.

The modeling effort consists of developing the model input parameters, calibrating the model to existing conditions, simulating the proposed extraction wells and then conducting a sensitivity analysis. This section describes each of these steps.

### Model Input Parameters

The base map for the modeled area was obtained from a digitized 7.5 minute quadrangle of the Rockton area with the Beloit Corporation plant building (BCP) added to it (See Figure 1). A 51 by 64 grid was created with spacing ranging from approximately 100 ft at the center of the site to approximately 250 ft at the site boundaries. The western, southern, and northern boundaries of the model are placed on the opposite side of the Rock River, so they have little if any effect on the model. The eastern model boundary is placed

approximately 3500 ft east of the BCP, in an area where the groundwater flow is shown to be primarily north to south, parallel to the model boundary.

The values for each model input are described in more detail in Appendix A. In general, the hydraulic conductivity was obtained from data presented in Technical Memoranda Nos. 1 and 2. The porosity was selected based on literature values (Freeze and Cherry, 1979) and modified based on the potential heterogeneity of the sand and silty sand zones (see discussion in Appendix A). The variation of hydraulic conductivity and porosity within the aquifer was defined in the model by five individual property boxes (Figure 2). The aquifer bottom elevation was based on cross-sections, borehole logs, and the top of clay map (Drawing -F6 presented in Technical Memorandum No. 2). The recharge rate (4 in./yr.) was based on an average percolation rate through non-sloping vegetated land in the midwest region of the United States. A file of input data for the calibrated model is in Appendix A of this report.

### **Model Calibration**

The model was calibrated to observed water levels at the site by modifying model input parameters within acceptable ranges. The Average Water Table Map (Drawing F15) was used as the basis for calibration. The calibration run for the entire modeled area is presented in Figure 1. A close-up of the site is shown in Figure 1A. Observed heads from 19 water table well locations on the Average Water Table Map were compared to model calculated heads by using a calibration routine in the FLOWPATH software. This comparison is presented in Table 1 and is presented graphically in Figure 4. The mean error for the final calibration run was -0.093181, and the root mean squared (RMS) error was 0.595542. The low RMS value indicates that the model has been calibrated within reasonable tolerances.

### **Removal Action Simulation**

A network of four groundwater extraction wells (see Drawing B1) were incorporated into the calibrated model. Figure 3 presents the simulated hydraulic head and capture zone. The number of wells and their locations were chosen to capture groundwater flow on the RA Site, as defined in the EE/CA. The RA Site is roughly the area within the Beloit Corporation property downgradient of well W23. The pumping rates for each well were also adjusted to achieve this capture zone (EW01-10 gpm, EW02-25 gpm, EW03-50 gpm, and EW04-55 gpm). Pumping rates at wells EW01 and EW02 were limited by hydraulic conductivities and aquifer thickness. The capture zone presented in Figure 3 is based on a particle travel time of four years.

The capture zones for the four extraction wells encompasses the entire RA Site. Therefore, it is expected that the groundwater within the RA Site will be captured by these four wells.

It should be recognized that this simulation of the extraction system is a steady state simulation, for a given set of conditions. Therefore, some time will be required to achieve the simulated conditions and changes in site conditions from that simulated may result in differences from the simulated results. Under average conditions, pumping at 140 gpm, it may take 6 months to achieve the drawdown depicted in Figure 3. Changes in river

elevations, rainfall recharge, or other conditions will occur that may result in groundwater levels either above or below the simulated conditions. However, the simulated extraction system is for an average set of conditions, and provides a reasonable basis for the design of the extraction well layout and pumping rates.

### Sensitivity Analysis

A sensitivity analysis was performed to determine possible variations from the calibrated model's simulated results. Three different extraction well flow rates, hydraulic conductivities, and recharge rates were changed, one at a time, to determine the range in hydraulic head and extraction system capture zones that would result. The extraction well flow rates were varied by reducing the combined flow by 50% and increasing the combined flow to a maximum rate (Figures 5 and 6). Hydraulic conductivities were varied by increasing all values by one order of magnitude, and decreasing all values by one half of an order of magnitude (Figures 7 and 8). Recharge rates were varied by increasing the rate to 8 in./yr (from 4 in./yr) and decreasing the recharge rate to 2 in./yr (Figures 9 and 10). None of the variations in the model runs are plausible because their results are very different than the Average Water Table Map elevation (Drawing F15 from the Phase 2 Work Plan), and do not accurately represent observed conditions. Additional discussion of the sensitivity analysis is located in Appendix A.

## SECTION 3: EXTRACTION WELL PLACEMENT

Four extraction wells are planned for installation at the Blackhawk Facility. The horizontal position for each extraction well is presented in Section 2, Basis for Design (see Drawing B2). This section (i.e., Section 3) describes the basis for the vertical placement of the wells.

Each of the wells will be installed in the immediate vicinity of an existing monitoring well so the stratigraphy at each location is known, approximately. Proposed locations of the extraction wells are:

<u>Extraction Well</u>	<u>Adjacent Monitoring Well</u>
EW01	W23/W23B
EW02	W41
EW03	W3R/W5R
EW04	W26/W26C

Well EW01, located near the point of release, is in an area with a significant layer of silty sand near the water table. There are several sand units within this silty sand layer that need to be screened within the well to achieve the desired pumping rate and capture zone. The extraction well will be screened to a depth similar to W23B, so as to capture the zone of contamination, but not be screened in the underlying sand unit which has no detectable VOCs. Wells EW02 through EW04 will be fully penetrating wells, so as to capture the zone of VOC affected groundwater and allow for more available drawdown.

A pilot boring will be performed at each of the extraction well locations prior to the drilling and installation of the extraction wells. This pilot boring will be used to identify whether the extraction well will encounter appropriate sand soils, especially at EW01, and to make final decisions on the extraction well design. The pilot borings will be drilled with reverse air rotary drilling methods. Drill cuttings will be logged according to the Unified Soil Classification System (USCS). Grain size analysis will be performed on each major change in stratigraphy. Modifications to the proposed filter pack and well screen specifications may be made based on the results of the pilot borings prior to mobilization of the rig for drilling the extraction wells.

The extraction wells will be drilled with air rotary, mud rotary, or cable tool. Each well will be thoroughly developed according to the specifications located in Appendix B.

#### **SECTION 4: WELL CONSTRUCTION**

Drawings A1, A2, A3, and A4 include tentative details concerning well depths, screened intervals, well dimensions, screen slot size, well materials, sand pack specifications, and well completion details. These details are based on boring logs from adjacent monitoring wells and available grain size analyses. Extraction well design details will be based on results of the pilot borings. Wells EW02, EW03, and EW04 will be fully penetrating to the top of the lower clay unit. Well EW01 will be terminated in the silty sand unit and will not be installed within the lower, uncontaminated sand unit.

The extraction well screens, sumps, and risers will be schedule 80 PVC. Unless modified by pilot boring data, the well screens intersecting the upper and lower sands will be 0.035 inch slot size with 0.7 mm to 0.8 mm filter pack material. Well screens intersecting the silty sands will be 0.05 inch slot with a natural pack. The well head completion will be a simple pitless adapter with a well stickup at wells EW02, EW03 and EW04. Well EW01 may have a flush mount completion if installed in the driveway outside the erection bay. Controls will be located in the treatment building.

The pumps in wells EW01 and EW02 are proposed to be placed at the bottom of the screen, with a shroud to divert water across the pump motor. This is done to maximize the available drawdown in these shallow wells. The pumps in wells EW03 and EW04 will be placed in the midpoint of the screen to allow for sufficient available drawdown yet allowing for sufficient cooling water to flow past the pump motor.

#### **SECTION 5: TREATMENT, COLLECTION, AND DISTRIBUTION SYSTEMS**

A site plan showing the location of remediation equipment is shown on Drawing B1, and a process flow diagram is shown on Drawing B2. The process flow diagram shows an air stripping tower as the air stripper technology. However, based on bids received from vendors, a low profile air stripper may be used. Design of the air stripper would allow for

changes in the flow rate and concentration with a range expected for this system. This would allow for increasing or decreasing the flow rate due to variance in the capacity of the wells, and changes in VOC concentrations. General specifications for an air stripping tower, and low profile air stripper are included in Appendix C. This includes a table of expected initial concentrations based on the design flow rate for each extraction well and expected groundwater concentrations in the area of each well. A flow rate of 140 gpm to 400 gpm was used in designing the air stripper to allow for a range of flow rates for the four planned wells and to allow for potential additions.

If discharge standards are not met by the air stripper, changes will be made to comply with the discharge limits. Changes to be considered would be additional treatment, such as activated carbon, or changes in extraction well pumping rates. If activated carbon is added, this equipment can be housed in a separate building located adjacent to the proposed treatment building.

Monitoring of the groundwater treatment system will be as indicated in Table 2. The groundwater remediation system will be designed to meet the applicable discharge standards. In accordance with 35 Ill. Adm. Code 215.301, no air emission controls are required because emissions from the remediation system are expected to be below 8 lbs/hr. As a result, the groundwater remediation system will meet air emission standards.

## **SECTION 6: MONITORING PLAN**

The monitoring plan for this Removal Action consists of sampling selected monitoring wells on the site and selected private wells in the Blackhawk Acres Subdivision. These monitoring plans are described in the following sections.

### **Monitoring Wells**

The wells listed in Table 3 were selected to measure the water table from the north end of the plant to the southern portion of the NPL Site. These wells will also be used to monitor the capture zones from the four extraction wells. Two new wells are proposed, one to be installed when access is arranged (W43C) and one contingent on system performance (W19C).

The contingent deep well (W19C) is proposed at the W19 location, depending on the performance of the extraction wells. If the water table maps, constructed using data collected during steady state operation of the extraction wells, indicates that the groundwater in the vicinity of W19 is captured by the extraction wells, no deep well will be installed at this location. If these water table maps indicate that groundwater in the vicinity of well W19 is not captured by the extraction wells, and the system pumping can not be modified to establish capture, then a monitoring well will be constructed at the W19 location. The well will be drilled to the top of the clay layer, estimated to be at a depth of approximately 80 ft. Drilling methods and well construction will use the methods described in the Phase II investigation for other deep wells. Well W19B is constructed to a depth of

approximately 60 ft, therefore, no water quality sampling will be conducted during drilling. The well screen will be placed in the most permeable unit below well W19B and above the clay unit. The preference will be to set the well screen at the sand/clay contact, if the sand at this depth is permeable. This well will be added to the quarterly sampling, if installed, for a period of 3 quarters.

All existing monitoring wells and staff gages listed in Table 3 will be monitored for water levels every other month for 12 months, starting immediately prior to startup of the extraction wells, to determine the capture zones from the extraction wells. These wells will be monitored quarterly thereafter. Reduction in the monitoring locations or frequency will be proposed, if appropriate.

The monitoring wells listed in Table 3, which are designated for water quality sampling, were selected to provide a zone of wells on the perimeter of the site and adjacent to extraction wells for monitoring groundwater quality changes through time. The monitoring wells that will provide the most useful data and may be used for modifying the system operation were designated for quarterly sampling. This includes wells with the highest concentrations distributed throughout the RA Site. Well W18, located off the RA Site in Blackhawk Acres is planned for quarterly monitoring because it is located near wells EW02 and EW04. The wells designated for annual sampling will provide data for areas where VOC concentrations are not expected to change or not expected to change rapidly (i.e., background, sidegradient, and downgradient). In addition, wells not expected to be used for modifying operation of the extraction system are planned for annual monitoring.

All new monitoring wells will be constructed in a manner similar to existing wells.

### **Private Wells**

Selected private wells are proposed to be monitored at the time of startup of the removal action, followed by routine sampling of private wells based on the results of the operation and monitoring of the system. The private wells will be sampled by IEPA, or its designate in accordance with the RI Sampling Plan. Table 3A provides a summary of wells planned for the initial round of monitoring and wells currently planned for the on-going monitoring. The initial sampling will be conducted at or shortly (within 2 weeks) after startup of the removal action. This will provide data on the existing conditions at the time of startup of the system. Routine sampling will be conducted on the schedule shown in Table 3A. This list of wells and frequency for routine sampling may be modified (i.e., increased, decreased or revised) based on the results of the system performance and evaluation of water levels and analytical results from the monitoring program. Prior to each routine sampling event, system performance data, water levels and analytical results will be provided to IEPA, along with any proposed modifications to the schedule shown in Table 3A. Modifications will be discussed with and agreed to by IEPA before implementation.

## **SECTION 7: SCHEDULE**

The anticipated schedule for implementing the removal action is to initiate operation of the system after completion of the public availability session (scheduled for April 18, 1996), and IEPA signing the Action Memorandum (anticipated to be completed before April 18, 1996). Operation and monitoring and reporting will be conducted as outlined in this report (Section 5 Treatment, Collection, and Distribution Systems and Section 6 Monitoring Plan).

## **SECTION 8: CRITERIA FOR ADJUSTING SYSTEM**

Monitoring data will be tabulated in tables and graphs, and evaluated on a quarterly basis to assess the effectiveness of the extraction and treatment systems. Bi-monthly status reports will be prepared which summarize operation, maintenance, and monitoring activities, and will include the following information:

### **Text**

- OM&M status, including:
  - Summary of OM&M activities
  - Changes to remedial system
  - Changes to site conditions
- Source control RA system performance evaluation, including:
  - System operation
  - System influence and well capacity
  - Contaminant mass removal
  - Treatment system efficiency
  - Groundwater quality
  - Summary
- Conclusions and recommendations

### **Tables**

- Summary of OM&M activities
- Summary of water elevations
- Summary of groundwater monitoring analytical results
- Summary of groundwater treatment system performance

### **Graphs**

- Cumulative contaminant removed versus time.

The primary criteria for adjusting the system will be the treatment system monitoring activities and the extraction wells' affects on residential wells. If water level monitoring or private well operations indicate the extraction system may have a detrimental affect on the private wells, the system's performance will be evaluated and operations modified to minimize its effect on the private wells. If treatment system monitoring indicates actual or potential variances from applicable discharge standards, steps will be taken to reduce the discharge. For example, if VOC concentrations in the discharge need to be reduced, changes in operation of the treatment system (e.g., increased air flow) or extraction system (e.g., lower flow from all or selected wells) will be made or changes to the treatment system will be made.

Another criterion to be used in assessing performance of the system will be the size of the groundwater capture zone. The objectives are to limit the potential for migration of VOCs on the RA Site. Therefore, if the capture zone does not extend to the RA Site boundary, and if there is additional capacity in the treatment system, changes in the extraction system may be made. These include the potential for increased pumping rates from one of the four wells (potentially reducing the flow at wells with larger than necessary capture zones or declining concentrations), or addition of another extraction well. The action will depend on the degree and area where the capture zone needs to be enhanced. This will be evaluated on a monthly basis with recommendations for potential changes made after six months of operation.

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**TABLE 1**  
 Groundwater Model Calibration Results  
 Removal Action Design Report  
 Beloit Corporation - Blackhawk Facility  
 Rockton, Illinois

X	Y	OBSERVED	CALCULATED	ERROR	WELL
4193.52	7866.72	726.3	727.305	1.005	W6
6394.66	8586.18	729	729.978	0.978	W16R
3539.32	6638.23	723.4	723.899	0.499	P1
4317.17	7245.62	725.2	725.693	0.493	W21
4849.49	6996.45	726.1	726.529	0.429	W22
5970.41	8719.32	729.5	729.626	0.126	W15
4679.24	7925.97	728.3	728.422	0.122	W23
5177.94	7268.27	727.4	727.485	0.085	W13
4917.44	6860.54	726.1	726.123	0.023	W2
3713.45	6342.98	723.1	722.991	-0.109	G109
5112.59	8500.06	729	728.831	-0.169	W28
4086.54	6986.47	724.8	724.478	-0.322	W20R
6359.36	7361.89	728.1	727.772	-0.328	W27
5297.4	8825.08	729	728.487	-0.513	W7
4024.36	6576.05	723.5	722.901	-0.599	G104
4724.9	6520.77	724.3	723.623	-0.677	W12R
4098.98	6600.92	723.7	722.922	-0.778	W3R
4940.1	6498.11	725.1	724.234	-0.866	G103S
4496.96	6115.88	722.9	721.729	-1.171	W26

**-0.093181 Mean Error**

**0.489052 Mean Absolute Error**

**0.595542 Root Mean Squared Error**

**TABLE 2**

**Treatment System Proposed Monitoring Program**  
**Removal Action Design Report**  
**Beloit Corporation - Blackhawk Facility**  
**Rockton, Illinois**

**Extracted Groundwater**

<u>Sampling Location</u>	<u>Analysis</u>	<u>Startup Frequency<sup>(1)</sup></u>	<u>Routine Frequency<sup>(2)</sup></u>
Groundwater system influent	VOCs (EPA SW-846 Method 8020) <sup>(6)</sup>	Weekly	Quarterly <sup>(3)</sup>
Groundwater remediation system	Flow Pressures	Every other day	Biweekly Biweekly
Groundwater system effluent <sup>(4)</sup>	VOCs (EPA SW-846 Method 8020) <sup>(6)</sup> Phenol <sup>(7)</sup> Phthalates <sup>(8)</sup>	Per the NPDES Permit	Weekly Monthly Monthly

**Air Emissions**

<u>Sampling Location</u>	<u>Analysis</u>	<u>Frequency</u>
Air stripper emissions <sup>(5)</sup>	None	--

**Footnotes:**

- (1) Startup sampling frequency is for the first week of operation.
- (2) Proposed frequency is for the first year of system operation. After that time, the monitoring program would be reevaluated and modified as appropriate.
- (3) Monitoring frequency will be monthly for the first three months of operation, and then quarterly thereafter.
- (4) Monitoring analysis and frequency will be in accordance with the NPDES permit requirements.
- (5) Monitoring of air stripper emissions is not included as part of the treatment system monitoring program because Illinois regulations do not require this. Air stripper emissions will be calculated based on comparing groundwater system influent and effluent concentrations each time influent and effluent analyses are conducted.
- (6) VOC analytical method EPA SW-846 8021 is equivalent to EPA Method 601/602 specified in 40 CFR Part 136, as required by the NPDES permit. Analytes required include: 1,1 Dichloroethane, 1,2 Dichloroethane, 1,1,1 Trichloroethane, Trichloroethene, Tetrachloroethene, 1,2 Dichloroethene, 1,1 Dichloroethene.
- (7) Phenol to be analyzed only if required in final NPDES permit. To be analyzed by Method 8270 which is equivalent to EPA method 604 specified in 40 CFR 136.
- (8) Phthalates noted below to be analyzed only if required in final NPDES permit. To be analyzed by Method 8270 which is equivalent to EPA Method 606, specified in 40 CFR 136. Analytes include: Bis(2-ethylhexyl) Phthalate, Dimethyl Phthalate, Diethyl Phthalate, Di-N-Butyl Phthalate

TABLE 3

**Proposed Site Monitoring Plan  
Removal Action Design Report  
Beloit Corporation-Blackhawk Facility**

Well ID	Location	Well Depth	80/21 Volatiles	Water Levels	Rationale
<b>Existing Groundwater Monitoring Wells</b>					
W02	existing	existing		X	
W08R	existing	existing		X	
W06	existing	existing		X	
W09	existing	existing		X	
W12R	existing	existing		X	
W16R	existing	existing	A	X	Upgradient well. VOC's not expected to change upgradient and results would not be used to modify extraction system operation. Therefore annual monitoring sufficient.
W18	existing	existing	Q	X	Located midway between EW02 and EW04 off the RA Site boundary. Only well in vicinity with significant VOC concentrations. Quarterly monitoring results may be used to adjust extraction system.
W19	existing	existing		X	
W19R	existing	existing		X	
W20R	existing	existing		X	
W20B	existing	existing		X	
W22	existing	existing		X	
W22C	existing	existing		X	
W23	existing	existing	Q	X	W23 is near point of release and has highest concentration observed. Quarterly monitoring results may be used to adjust extraction system.
W23B	existing	existing	Q	X	Deeper than W23B with lower concentration. Results at W23 would be used to evaluate system operation rather than W23B.
W25C	existing	existing	Q	X	Adjacent to EW01 in zone with highest VOC concentration. Quarterly monitoring results may be used to adjust extraction system.
W26	existing	existing	Q	X	Adjacent to EW04 in zone with highest VOC concentration. Quarterly monitoring results may be used to adjust extraction system.
W26C	existing	existing	-	X	
W28	existing	existing	-	X	
W29	existing	existing	A	X	Location is expected to be in downgradient area, unaffected by the site. Annual monitoring sufficient to monitor slow changes expected in this area.
W29C	existing	existing	-	X	
W31C	existing	existing	-	X	
W32	existing	existing	A	X	Located near the edge of the plume. Annual monitoring will be sufficient to observe slow changes expected at this location. More frequent results would not be used to monitor system response.
W34	existing	existing	-	X	
W38	existing	existing	Q	X	Located midway between EW01 and EW03 with highest concentration in the area. Quarterly monitoring results may be used to adjust extraction system.
W41	existing	existing	Q	X	Located near EW02 with highest concentration in the area. Quarterly monitoring results may be used to adjust extraction system.
W42	existing	existing	-	X	Located near EW01.

TABLE 3

**Proposed Site Monitoring Plan  
Removal Action Design Report  
Beloit Corporation-Blackhawk Facility**

Well ID	Location	Well Depth	8021 Vadose Levels	Water Levels	Rationale
W4-C	existing			X	located in subdivision. No VOC's detected at this location.
W45	existing	existing		X	
W46	existing	existing		X	
G103S	existing	existing		X	
G104	existing	existing		X	
G108S	existing	existing		X	located in downgradient area, unaffected by the site. Annual monitoring sufficient to monitor slow changes expected in this area.
(G108D)	existing	existing		A	located in downgradient area, unaffected by the site. Annual monitoring sufficient to monitor slow changes expected in this area.
(G109)	existing	existing		X	
G110	existing	existing		X	
p1	existing	existing		X	
<b>Proposed Groundwater Monitoring Wells</b>					
W19C	Nested with W19, W19B	Approximately 80 ft	Q	X	To be installed and added to the monitoring only if the capture zone is shown not to extend to this area.
W43C	Downgradient of well nest W26/W26C	Approximately 70 ft	A	X	Location is expected to be in downgradient area, unaffected by the site. Annual monitoring sufficient to monitor slow changes expected in this area. To be added as soon as access for a location is determined.
<b>Staff Gauges</b>					
SG6	existing	NA		X	
SG7	existing	NA		X	
SG8	existing	NA		X	
SG9	existing	NA		X	
SG10	existing	NA		X	

**Notes:**

1. Q = Quarterly sampling
2. A = Annual sampling
3. X = Water levels will be collected every other month for 0-12 months, and quarterly thereafter.
4. Groundwater Quality analysis for volatile organic compounds will be performed according to EPA method SW846 (8010/8021).

TK-SubP/R/Q  
J.S.R. SANDBERG, M.D.  
SW846 (8010) MD  
3/28/96

**TABLE 3A**

**Proposed Private Well Monitoring Plan  
Removal Action Design Report  
Beloit Corporation-Blackhawk Facility**

Initial sampling, at Removal Action Startup:	Routine Sampling	Frequency
910 Watts	910 Watts	Q*
914 Watts	914 Watts	A
918 Watts	918 Watts	A
1102 Blackhawk	1102 Blackhawk	S
407 Central	407 Central	S
1012 Blackhawk	1012 Blackhawk	S
1016 Blackhawk.	1011 Watts	S
909 Watts	1016 Blackhawk.	S
913 Watts		
917 Watts		
1005 Watts		
1007 Watts		
1009 Watts		
1011 Watts		

Notes:

\*Quarterly sampling should be conducted at one of wells 910, 914 or 918 Watts and annual at the other two. The wells selected for quarterly vs. annual are arbitrary.

Q = quarterly sampling

S = Semi-annual sampling

A = Annual sampling

Sampling to be conducted by IEPA, or its designate.

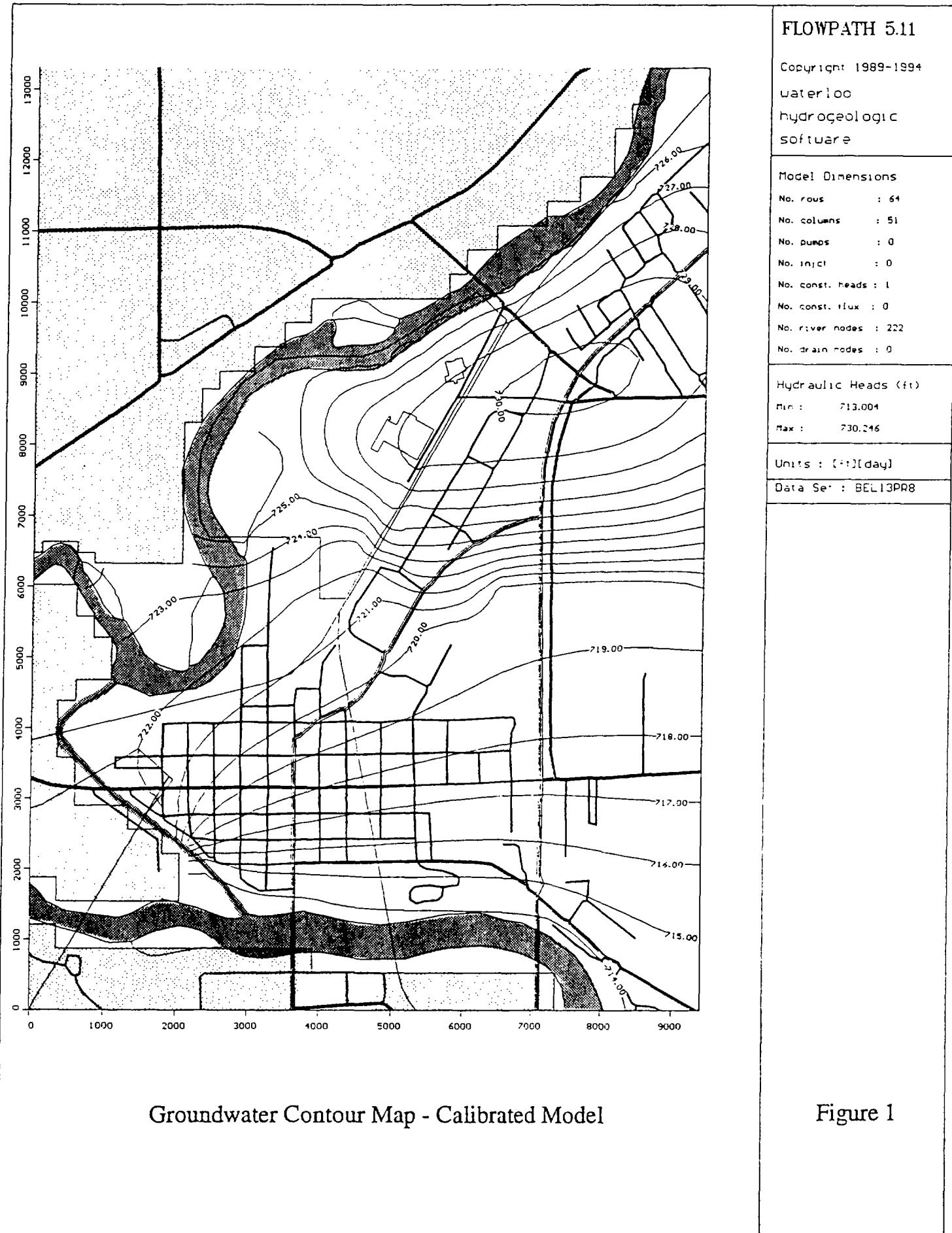
Analyses to be conducted for VOCs using EPA Method 524 to obtain Level III DQO.

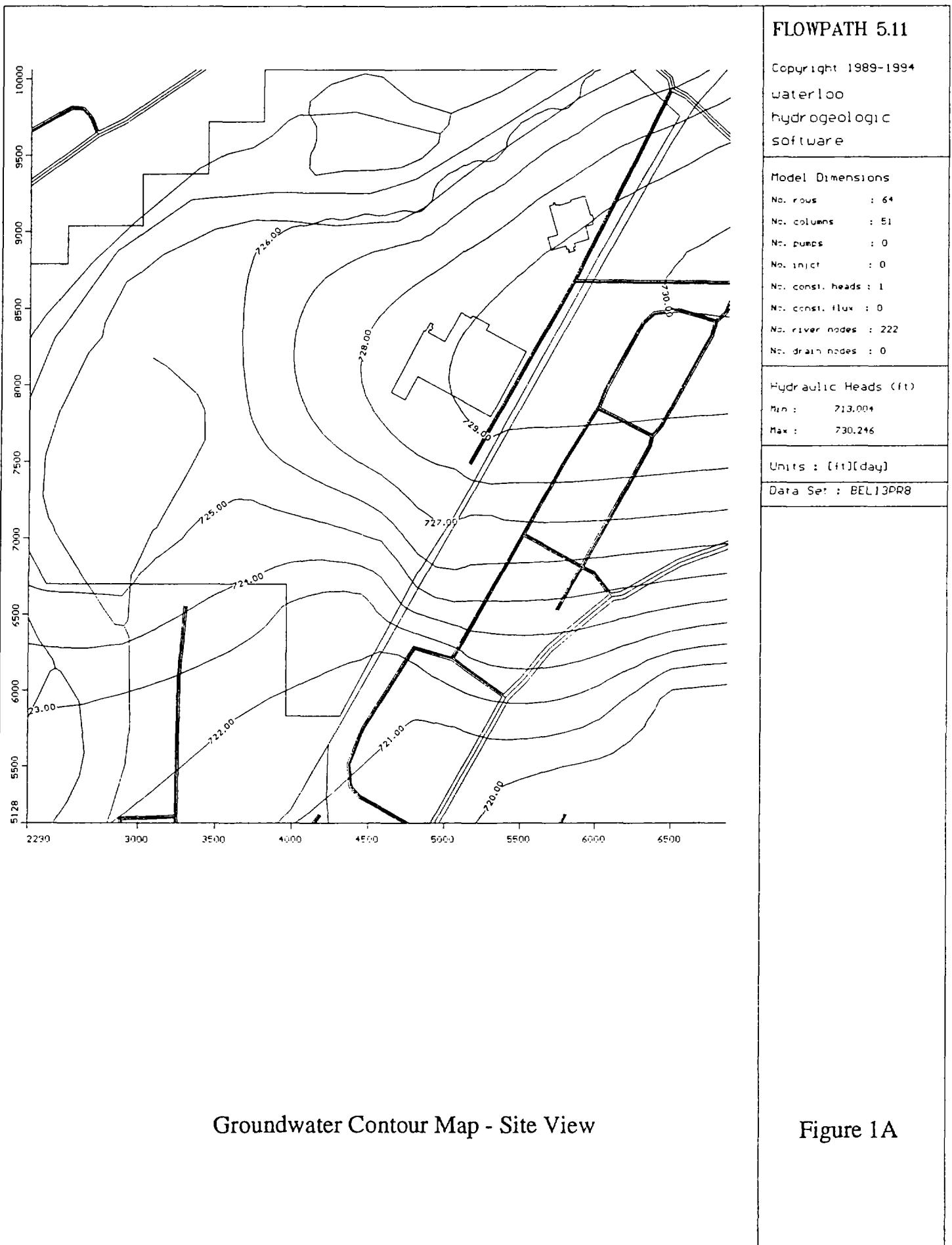
KJQ/kjq/RJR  
J:\3856\008\0nb13a.xls

TABLE 4

**Anticipated Schedule**  
**Removal Action Design Report**  
**Beloit Corporation - Blackhawk Facility**  
**Rockton, Illinois**

BALDWIN K. JO  
138564 SCRATIME.AIS  
3856.00441-MD  
2/25





**FLOWPATH 5.11**

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waterloo

hydrogeologic  
software**Model Dimensions**

No. rows : 64

No. columns : 51

No. pumps : 0

No. inject : 0

No. const. heads : 1

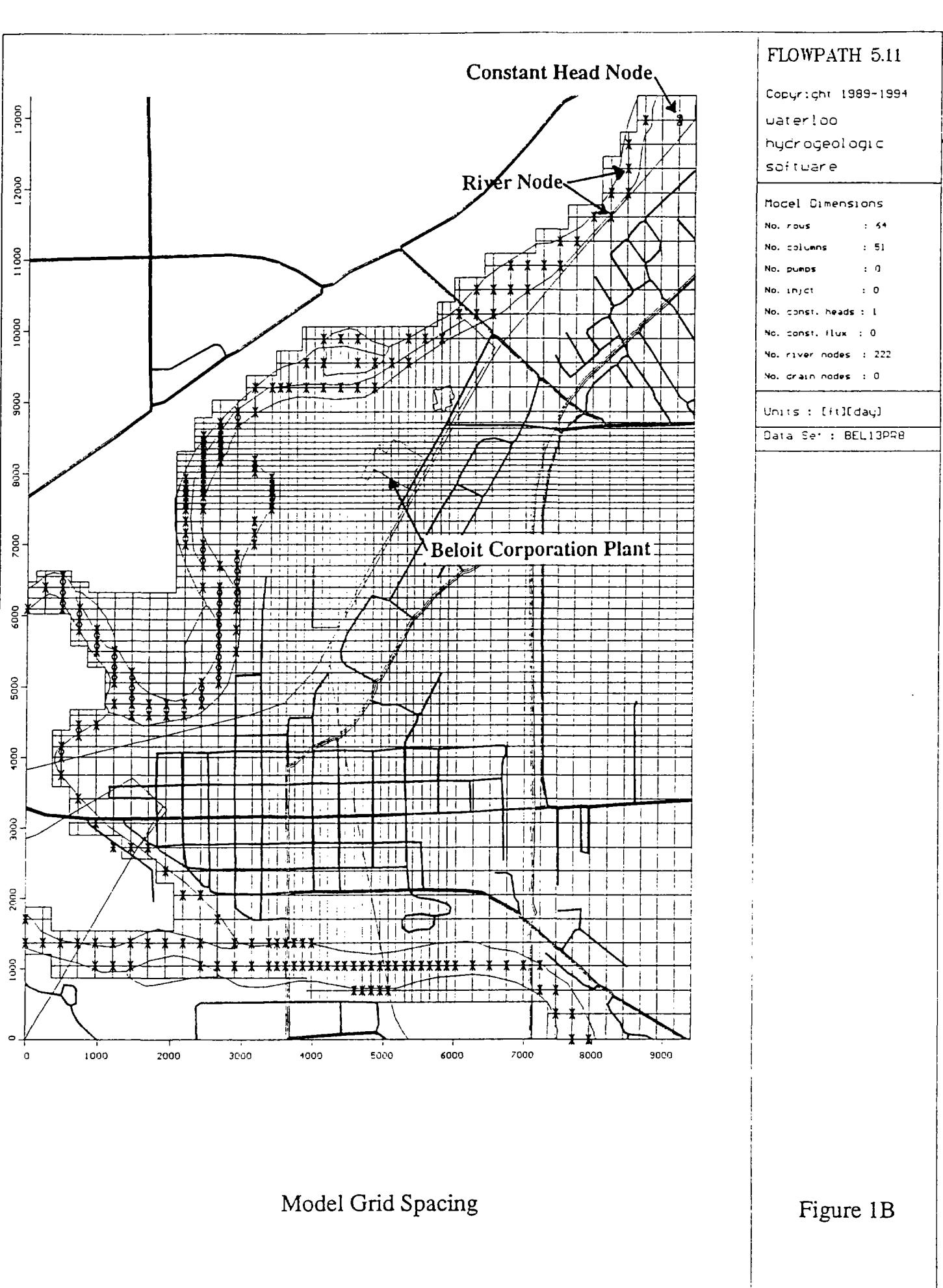
No. const. flux : 0

No. river nodes : 222

No. drain nodes : 0

Units : [ft][day]

Data Set : BEL13PR8



## FLOWPATH 5.11

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## Model Dimensions

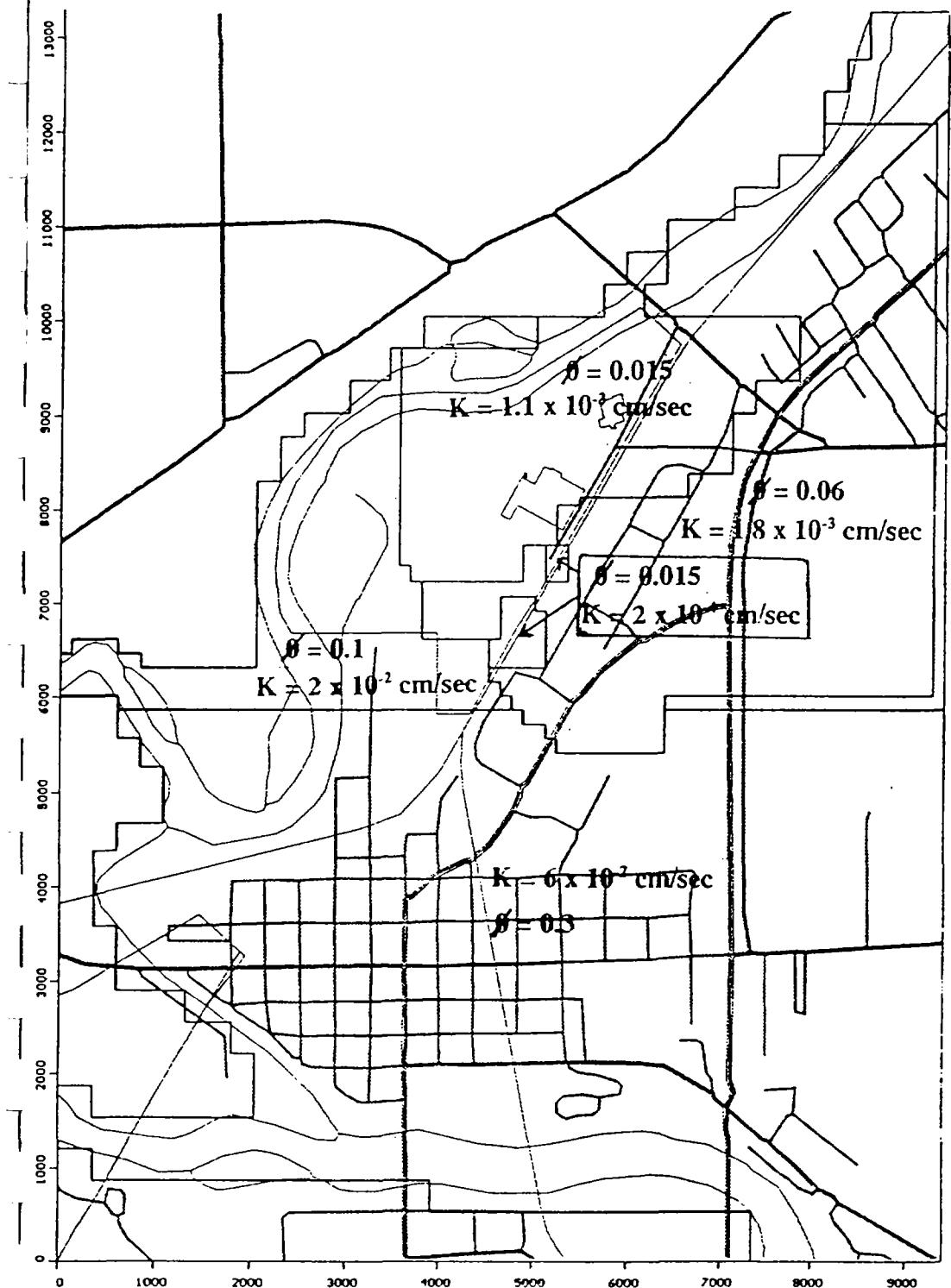
No. rows : 64  
No. columns : 51  
No. pumps : 0  
No. inject : 0  
No. const. heads : 1  
No. const. flux : 0  
No. river nodes : 222  
No. drain nodes : 0

## Hydraulic Heads (ft)

Min : 713.001  
Max : 730.216

Units : [ft][day]

Data Set : BEL13PRB

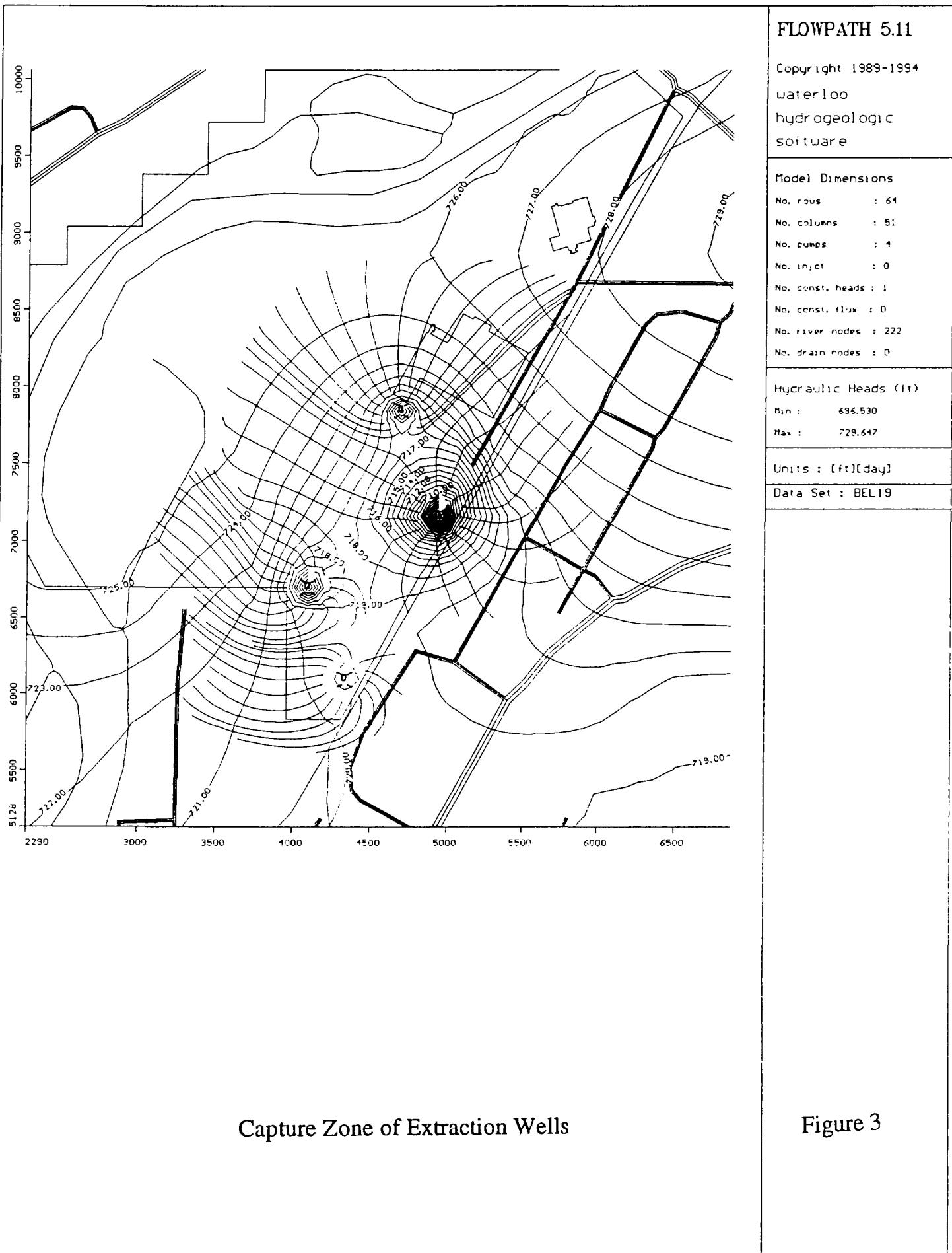


K = Hydraulic Conductivity

$\theta$  = Effective Porosity

Aquifer Properties (Groundwater Model),

Figure 2



Comparison of Observed Heads to Calculated Heads

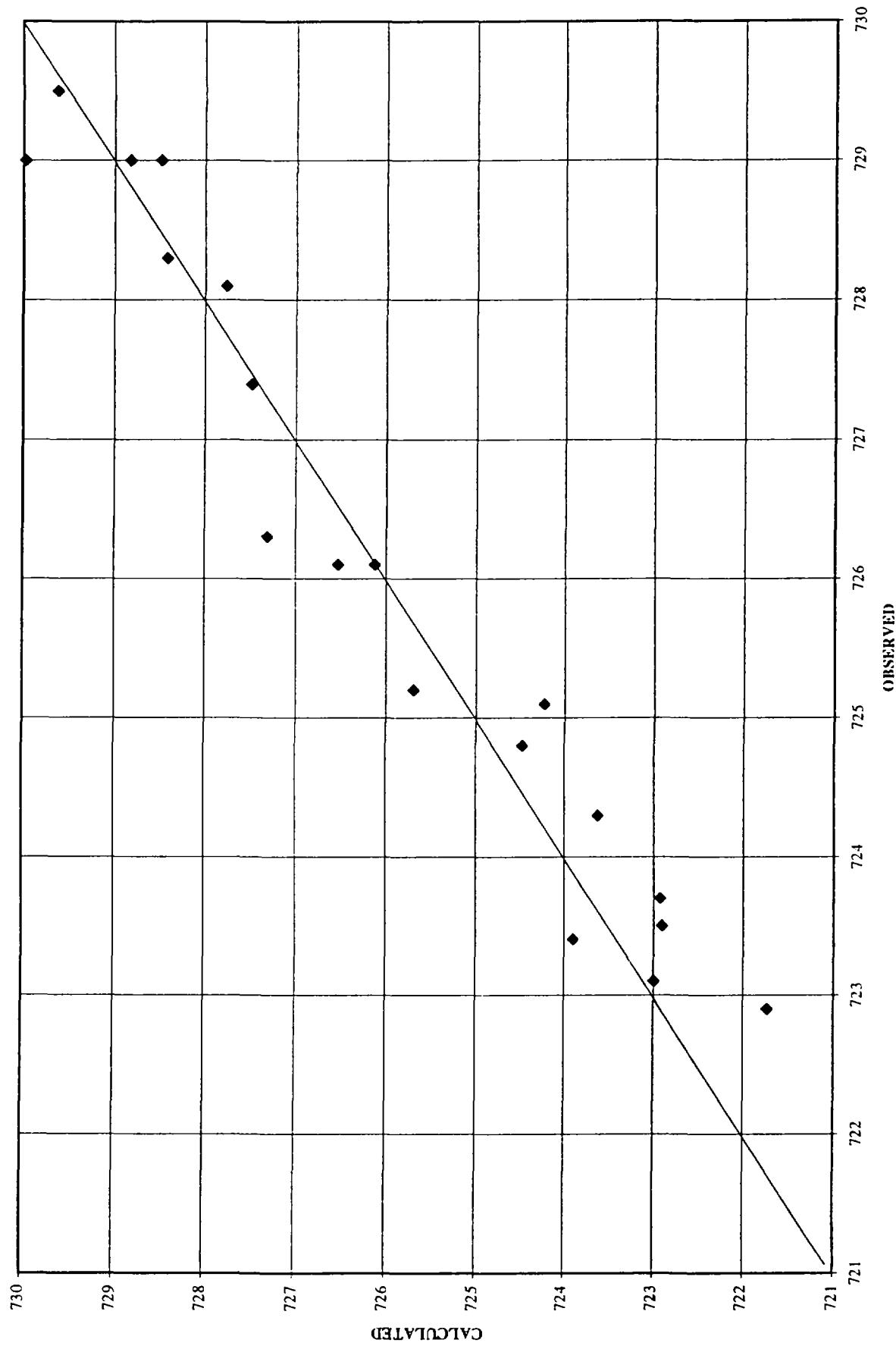
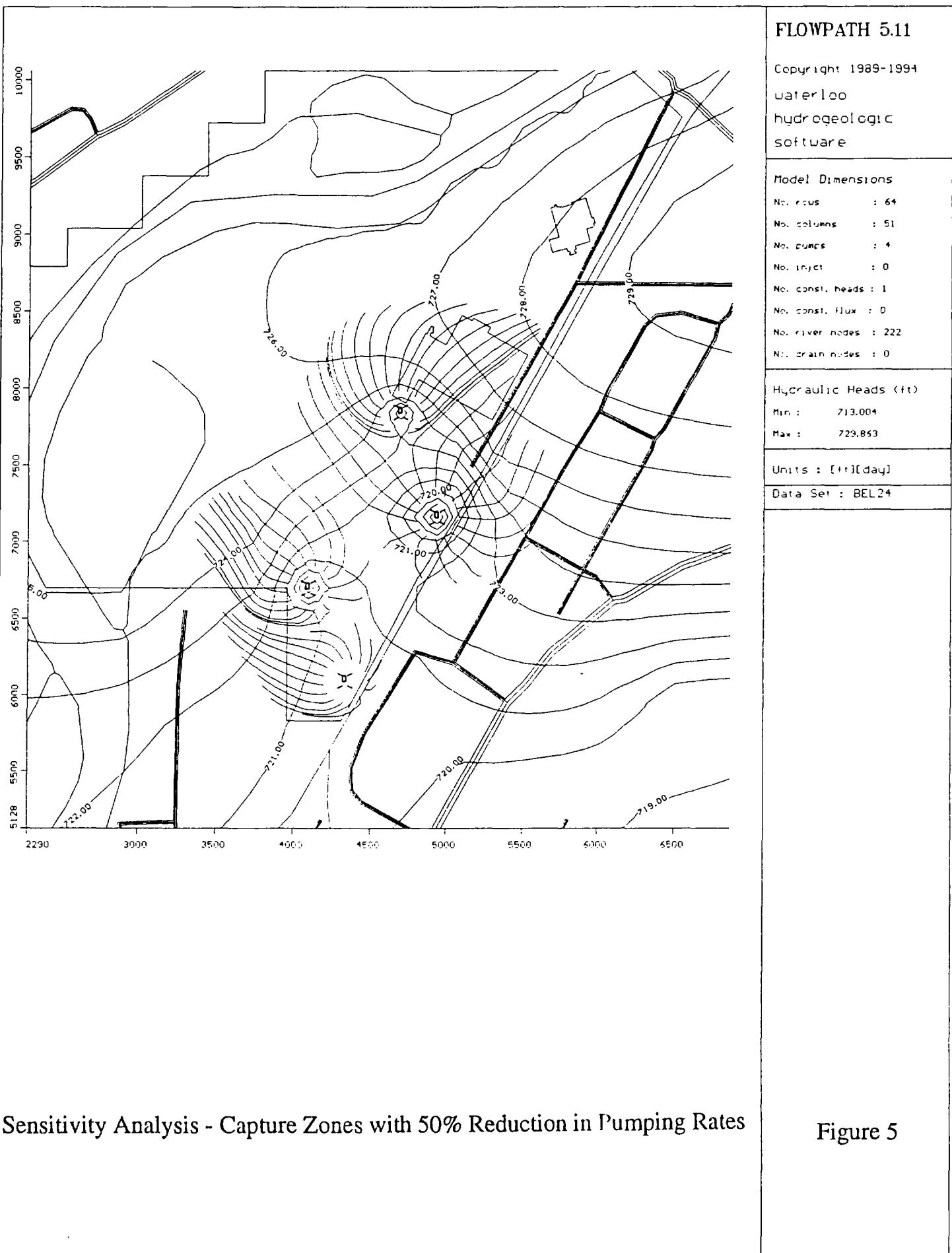
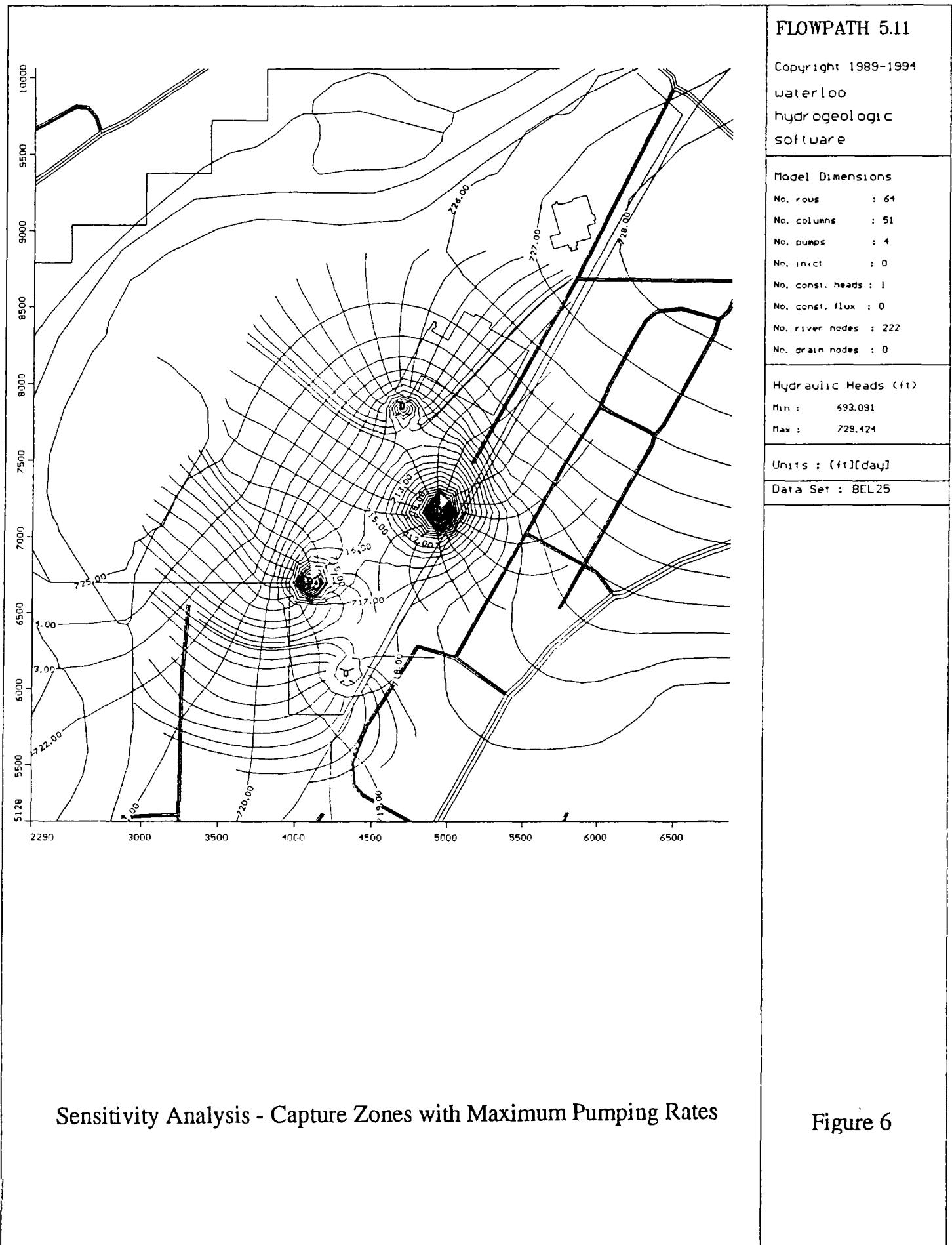
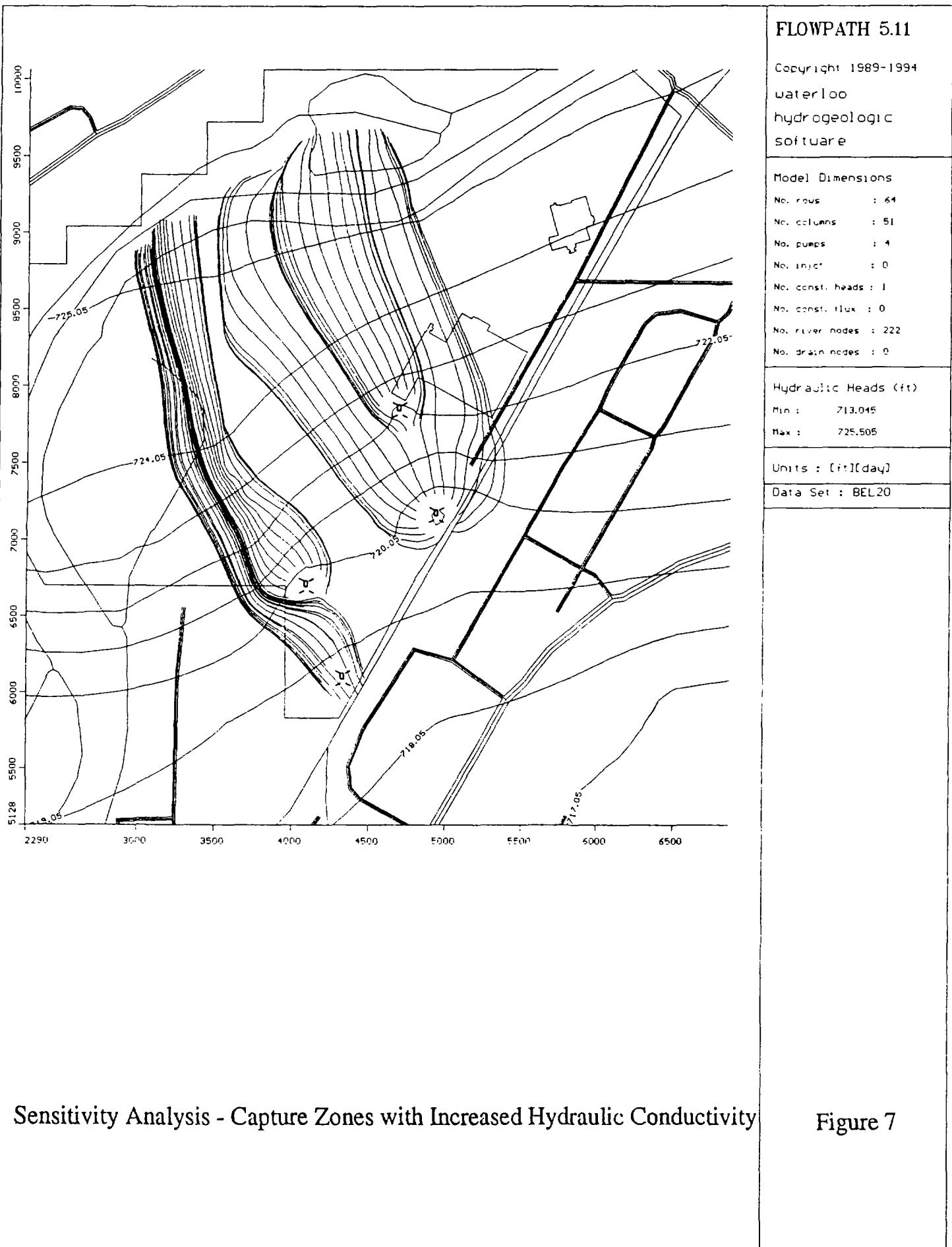
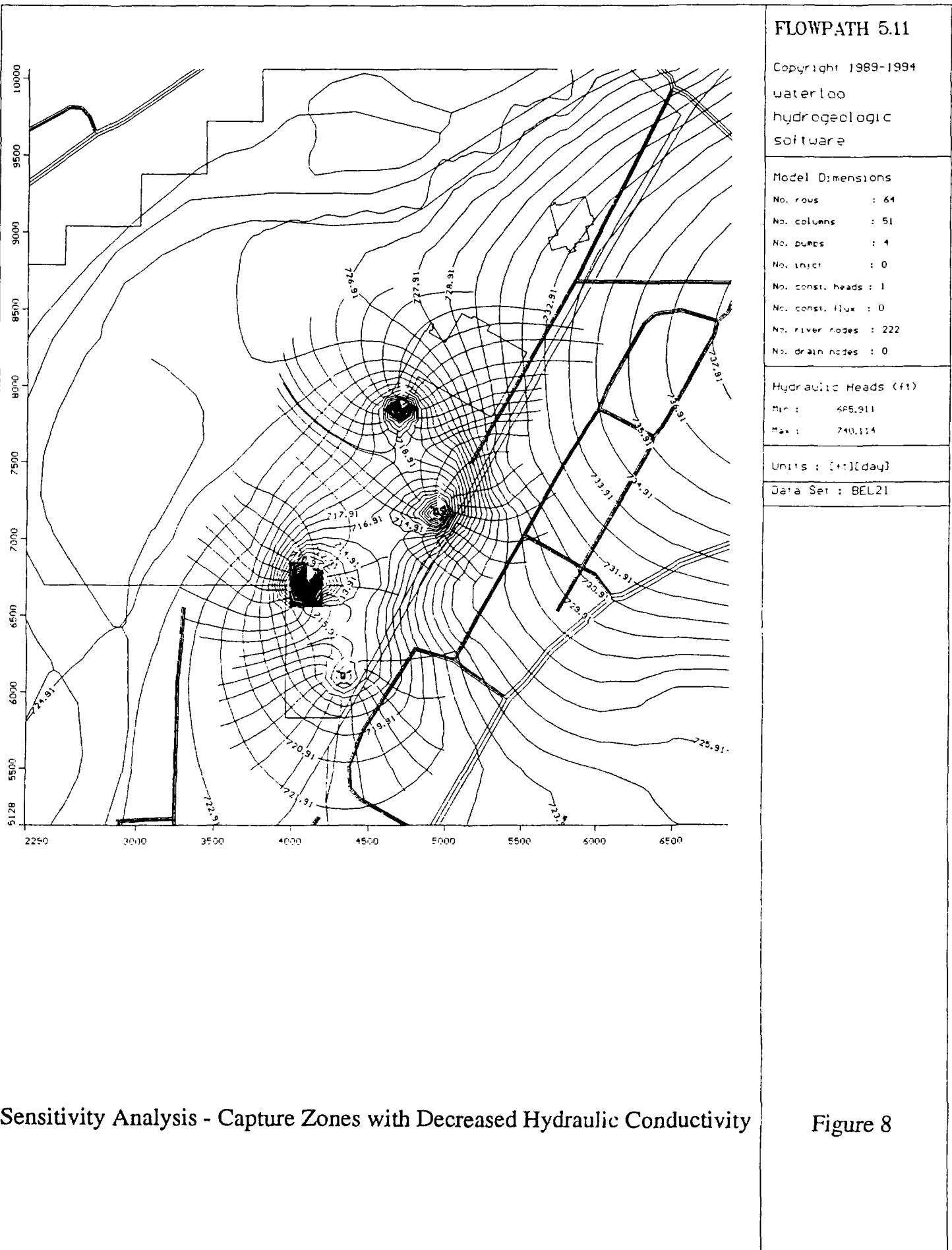


Figure 4



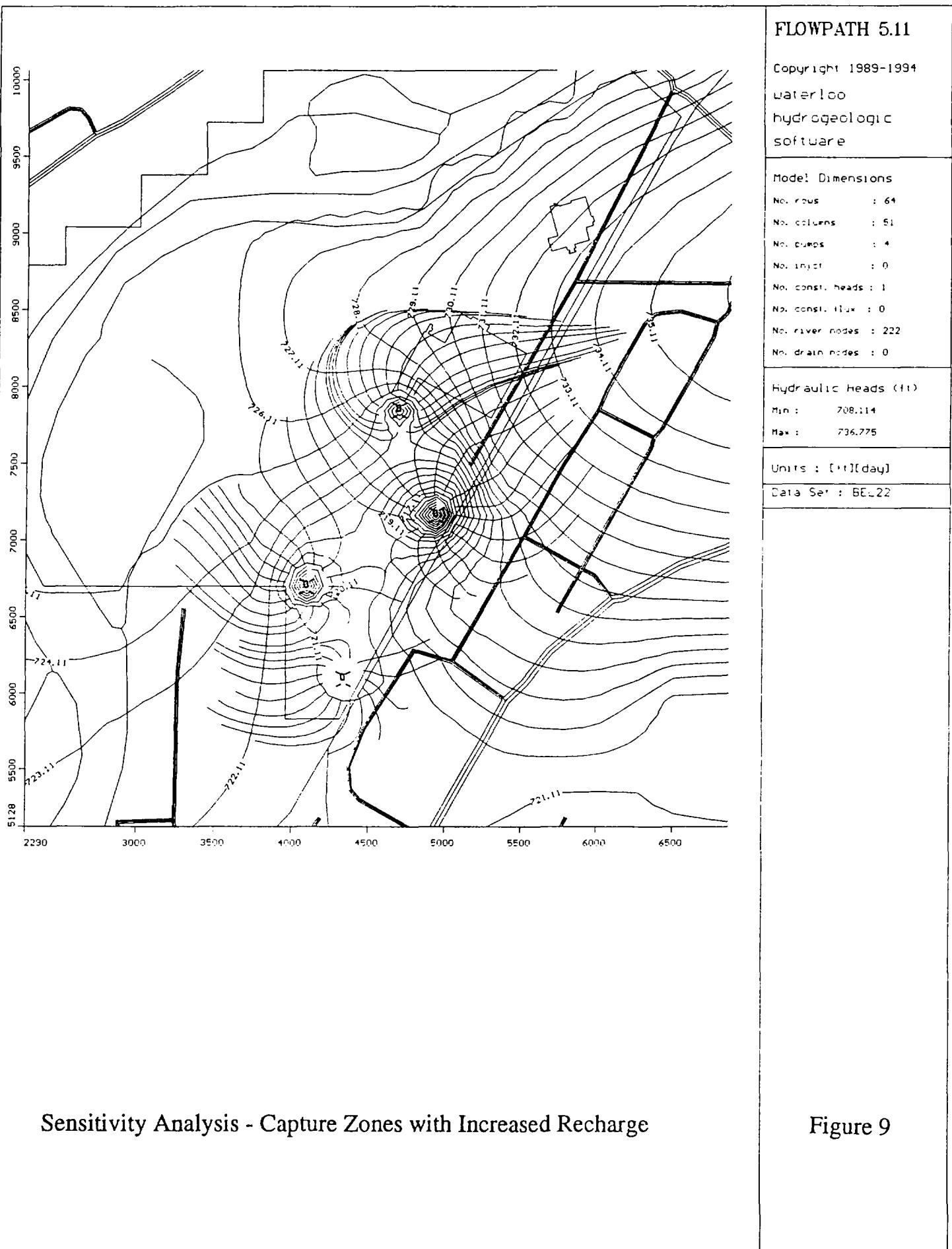


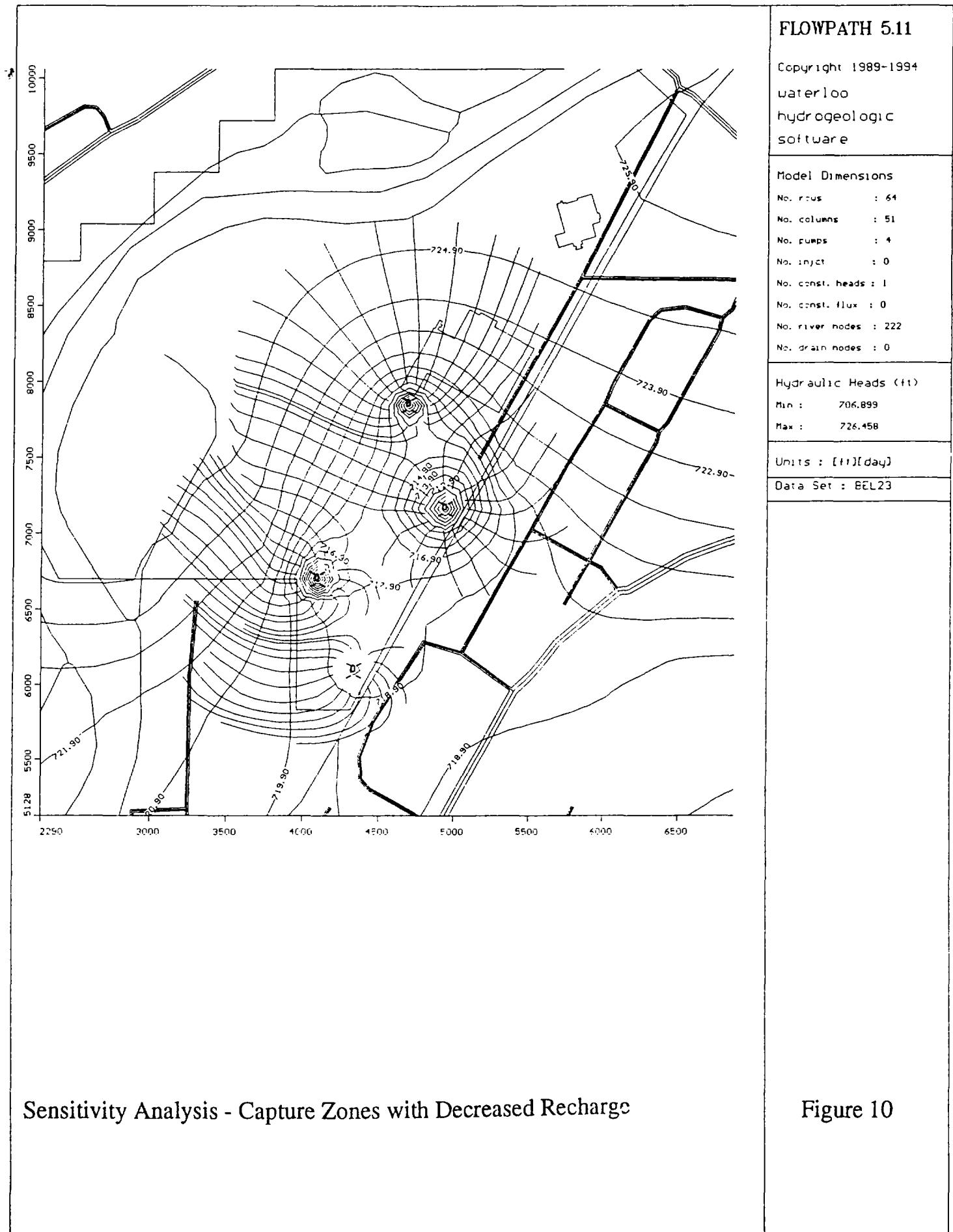




## Sensitivity Analysis - Capture Zones with Decreased Hydraulic Conductivity

Figure 8





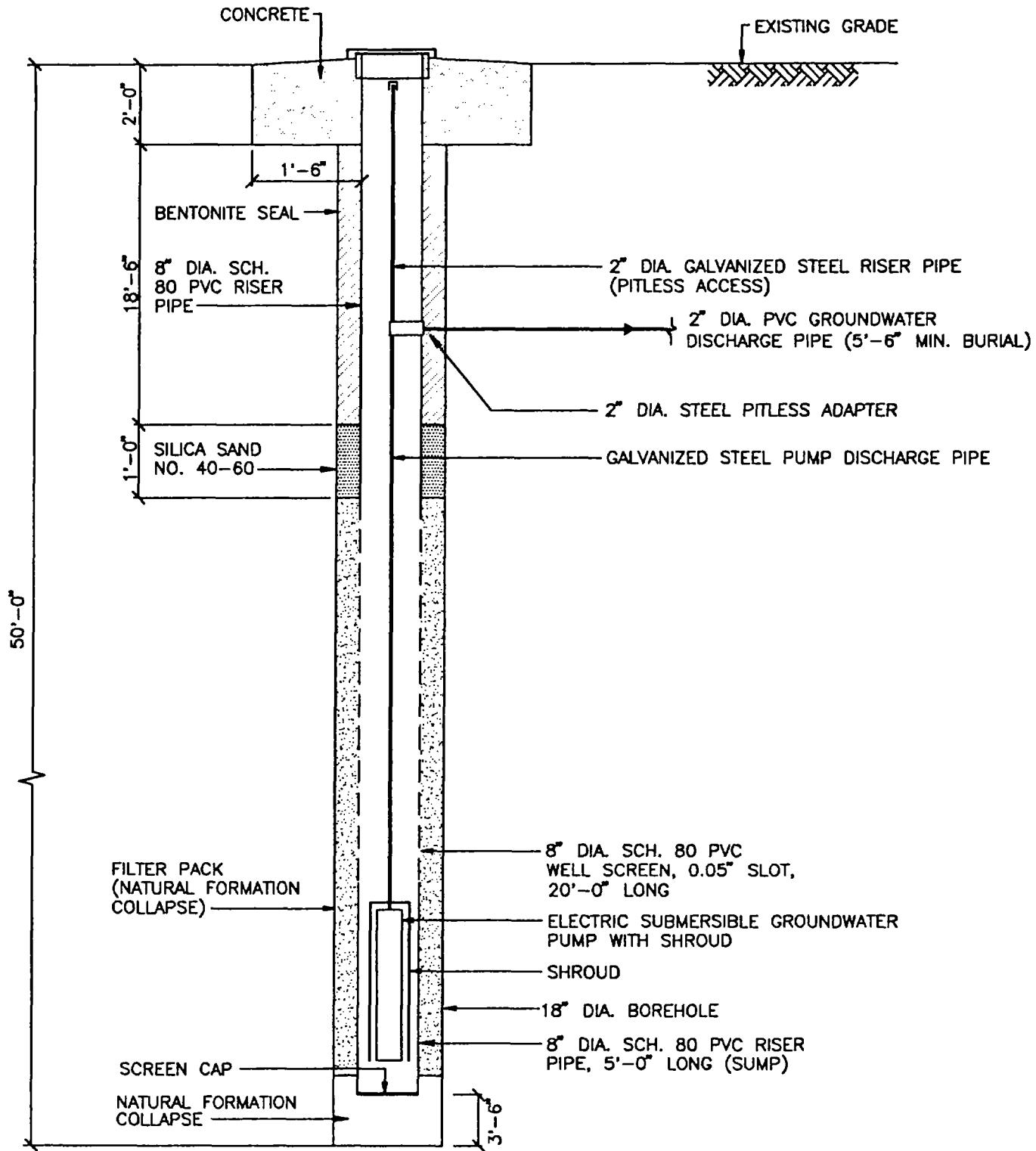
Sensitivity Analysis - Capture Zones with Decreased Recharge

Figure 10

Quality Control	Graphic Standards - TMS	06-28-95	Technical Review	06-28-95
Lead Professional	TJK	06-28-95	Project Manager	KJQ

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Management Review
Other

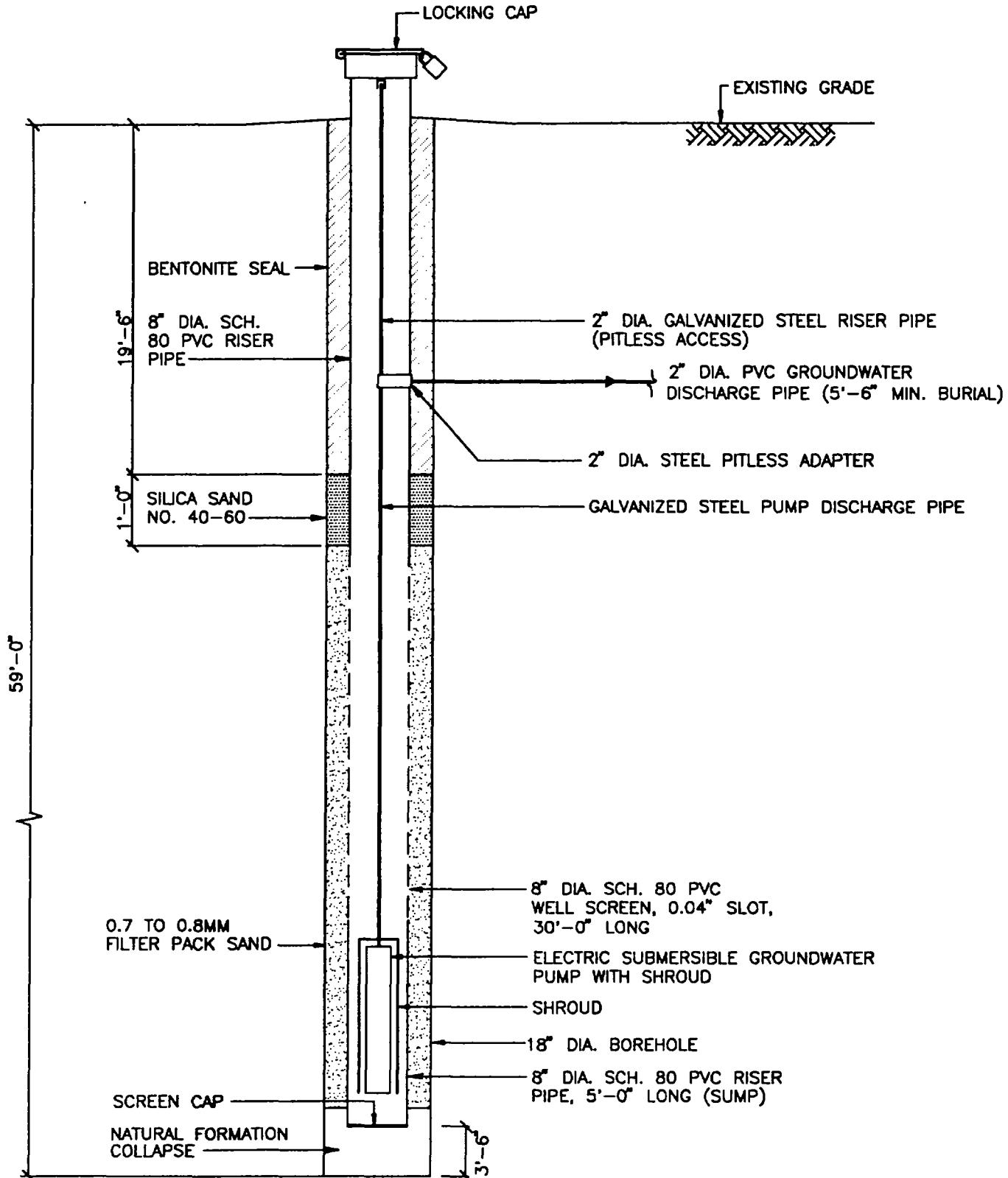


NOT TO SCALE

Developed By TJK	Drawn By LCL	RECOVERY WELL DETAIL (EW01)	Drawing Number 3856.0080
Approved By <i>[Signature]</i>	Date 4-11-96	REMOVAL ACTION DESIGN REPORT BELOIT CORPORATION BLACKHAWK FACILITY TOWN OF ROCKTON, WINNEBAGO COUNTY, ILLINOIS	A1
Reference 1536303-A2	MONTGOMERY WATSON		
Revisions			

Management Review	
Graphic Standards	TMS
Lead Professional	TJK
Quality Control	
Technical Review	06-28-95
Project Manager	KDQ
Other	06-29-95

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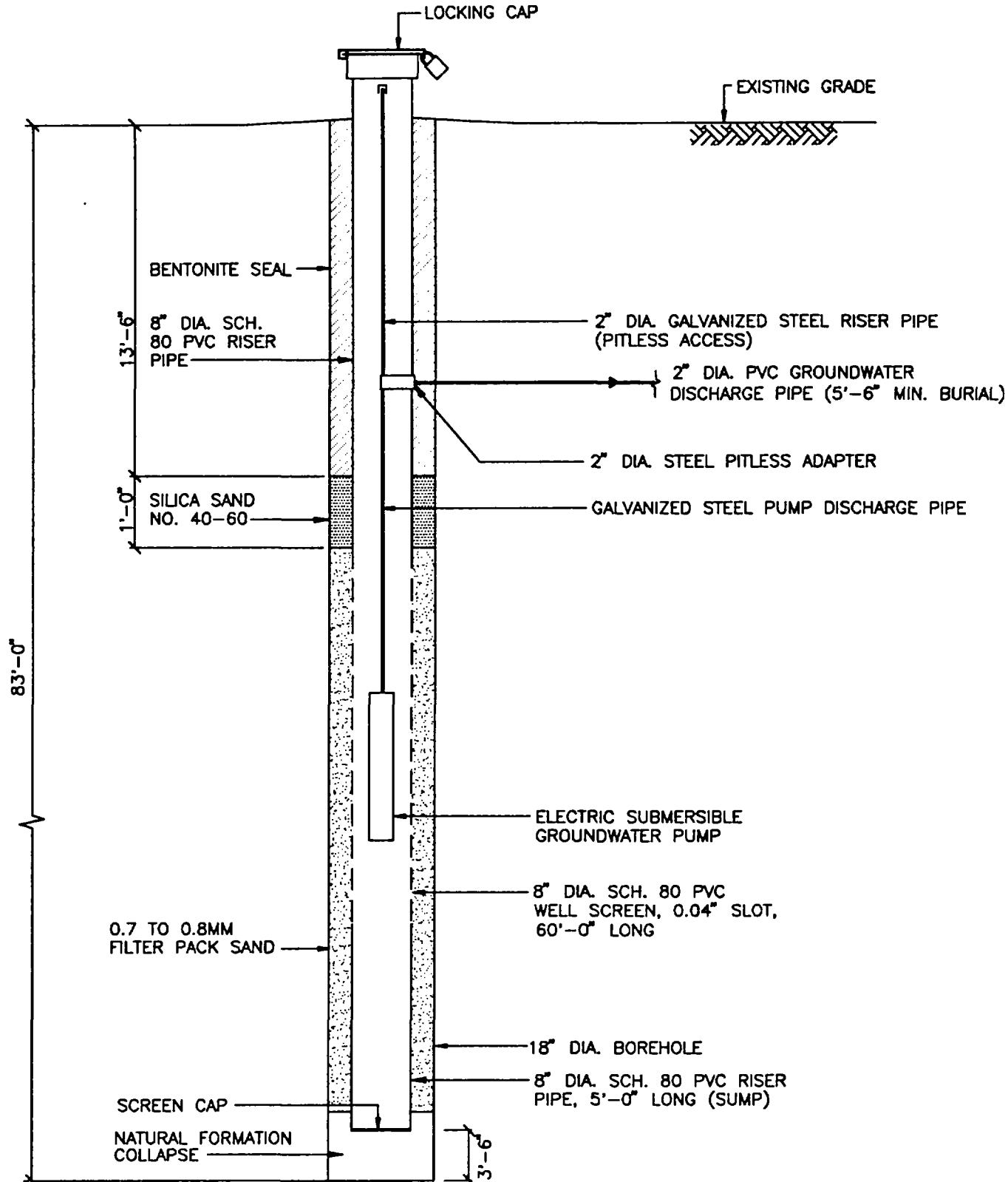


**NOT TO SCALE**

Developed By TJK	Drawn By LCL	RECOVERY WELL DETAIL (EW02)	Drawing Number 3856.0080 A2
Approved By <i>J. Hart</i>	Date 4-11-96	REMOVAL ACTION DESIGN REPORT BELOIT CORPORATION BLACKHAWK FACILITY TOWN OF ROCKTON, WINNEBAGO COUNTY, ILLINOIS	MONTGOMERY WATSON
Reference 1536303-A2			(M) (W)
Revisions			

Management Review	
Technical Review	
Project Manager	KJQ
Date	06-29-95
Graphic Standards	TMS
Lead Professional	TJK
Date	06-28-95
Quality Control	
Other	

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

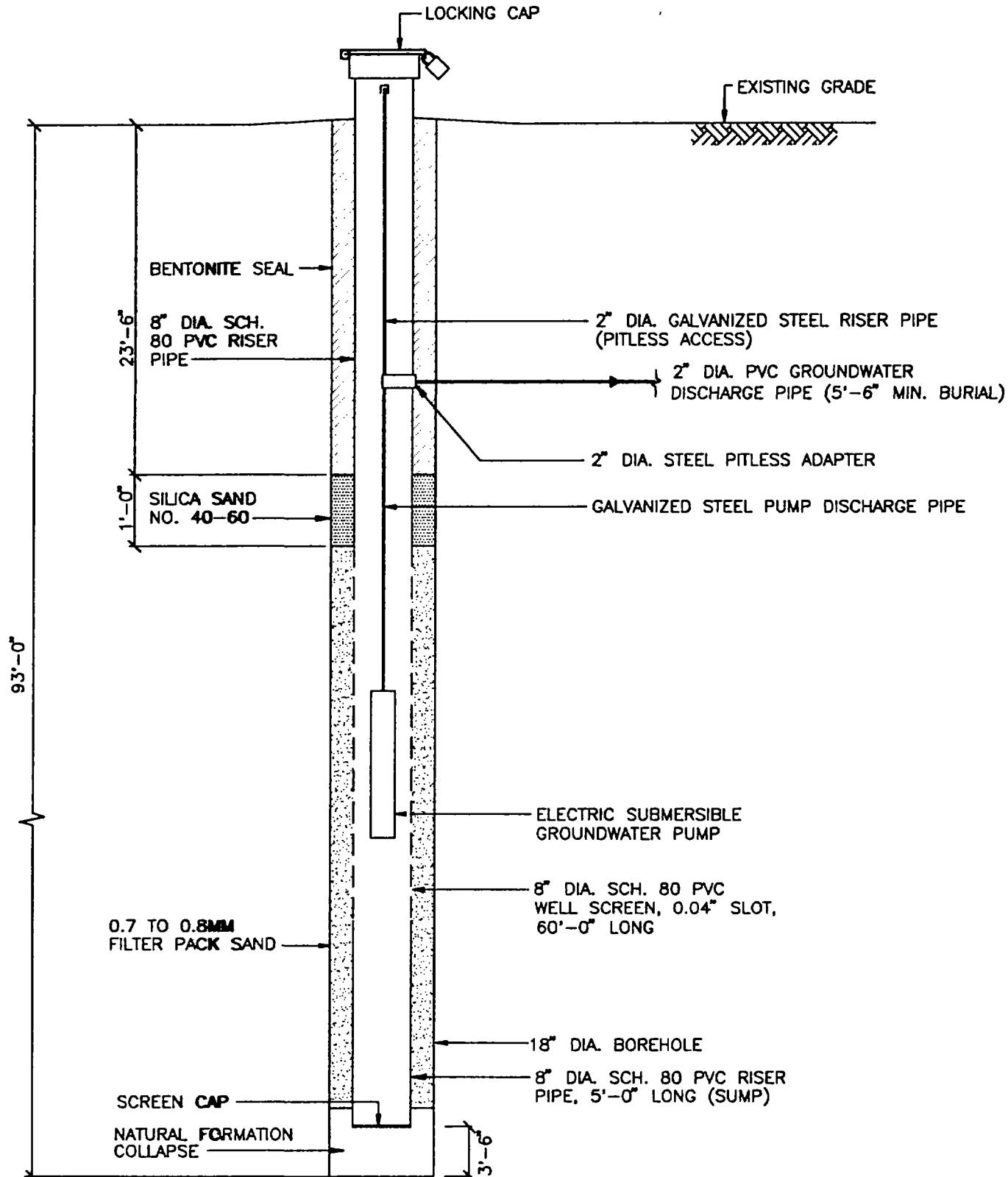


NOT TO SCALE

Developed By TJK	Drawn By LCL	RECOVERY WELL DETAIL (EW03)	Drawing Number 3856.0080 A3
Approved By <i>J. Hunter</i>	Date 4-11-92	REMOVAL ACTION DESIGN REPORT BELOIT CORPORATION BLACKHAWK FACILITY TOWN OF ROCKTON, WINNEBAGO COUNTY, ILLINOIS	
Reference 1536303-A2	MONTGOMERY WATSON		
Revisions			

Quality Control	Graphic Standards TMS	06-28-95	Technical Review	KJQ	06-28-95	Project Manager	TJK	06-28-95	Other
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Developed By TJK	Drawn By LCL	RECOVERY WELL DETAIL (EW04)	Drawing Number 3856.0080 A4
Approved By <u>I. Hartel</u>	Date 4-11-96	REMOVAL ACTION DESIGN REPORT BELOIT CORPORATION BLACKHAWK FACILITY TOWN OF ROCKTON, WINNEBAGO COUNTY, ILLINOIS	
Reference 1536303-A2	MONTGOMERY WATSON		
Revisions			

## LEGEND

	SPOT ELEVATION
	GROUND CONTOUR
	TREES AND SHRUBS
	MARSH
	EDGE OF WATER
	FENCE LINE
	RAILROAD TRACKS
	BUILDING
	MONITORING WELL LOCATION AND NUMBER
W #	SHALLOW WELL
W #B	INTERMEDIATE WELL
W #C	DEEP WELL
R	REPLACED WELL
G ##	GOVERNMENT WELL
S	SHALLOW
D	DEEP
	PHASE 2 GROUNDWATER QUALITY BORING LOCATION AND NUMBER
	APPROXIMATE BELOIT CORPORATION PROPERTY LINE
	FOUNDRY SAND DISPOSAL AREA
	FIBROUS SLUDGE SPREADING AREA
	REMOVAL ACTION SITE BOUNDARY
	PROPOSED GROUNDWATER EXTRACTION WELL LOCATION AND NUMBER
	PROPOSED MONITORING WELL TO BE INSTALLED DURING REMOVAL ACTION IMPLEMENTATION
	PROPOSED LOCATION OF REMEDIATION SYSTEM PIPING
	UNDERGROUND POWER LINE

## NOTES

1. BASE MAP DEVELOPED FROM AN AERIAL SURVEY  
PERFORMED BY KBM, INC., GRAND FORKS,  
NORTH DAKOTA. DATE OF PHOTOGRAPHY:  
NOVEMBER 1990.
2. ELEVATIONS ARE BASED ON U.S.G.S. DATUM  
(MEAN SEA LEVEL (MSL)).
3. GRID BASED ON ILLINOIS STATE PLANE  
COORDINATE SYSTEM.

## SITE FEATURES MAP

REMOVAL ACTION DESIGN REPORT  
BELoit CORPORATION BLACKHAWK FACILITY  
SECTIONS 12 AND 13, T46N, R1E  
TOWN OF ROCKTON, WINNEBAGO COUNTY, ILLINOIS

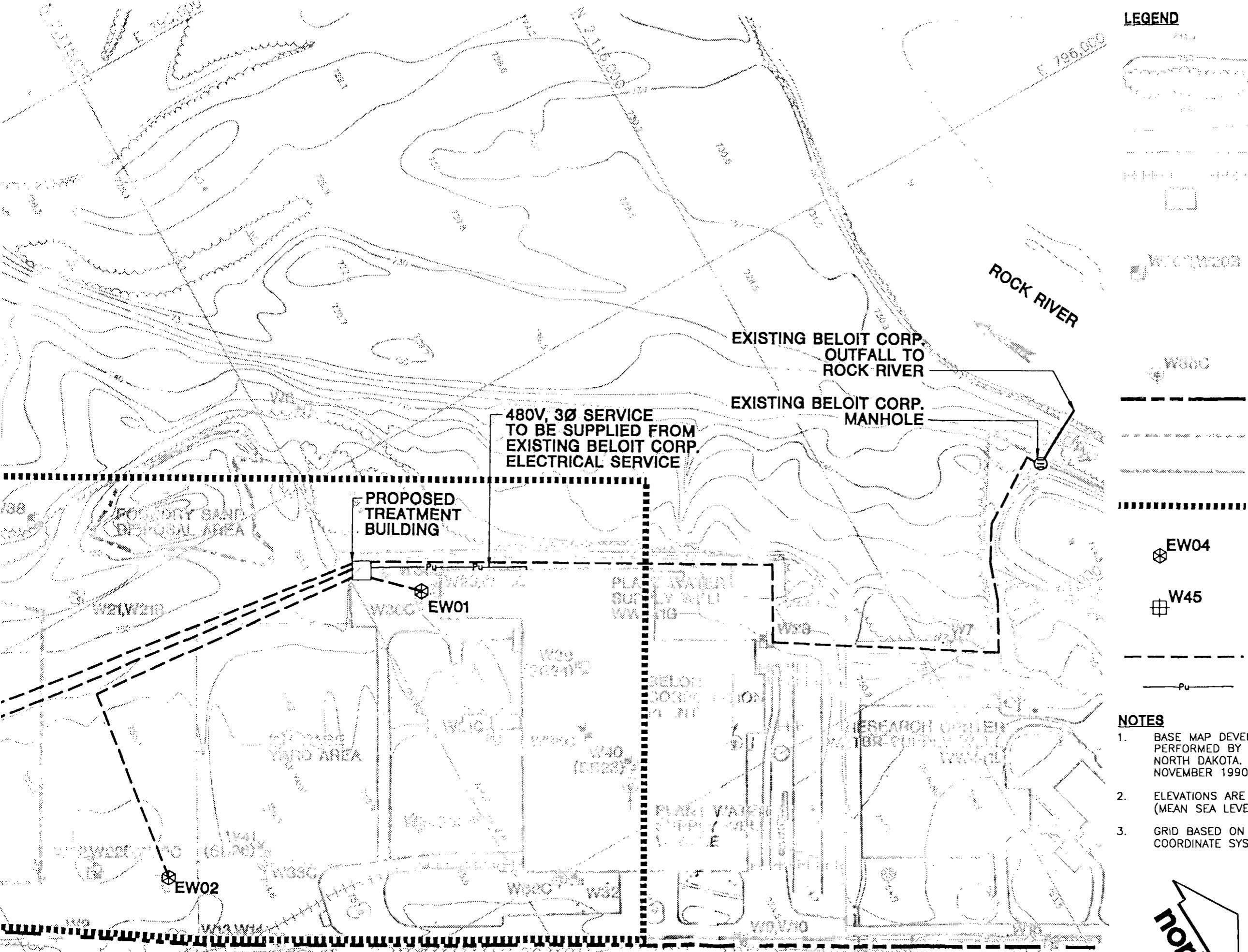
Drawing Number  
3856.0080 B

MONTGOMERY  
WATSON

Developed By CRM	Drawn By TMS,CCM
Approved By [Signature]	Date 4-11-96
Reference [Signature]	Revisions

90V 3Ø SERVICE  
BE SUPPLIED FROM  
TING BELOIT CORP.  
ELECTRICAL SERVICE

EXISTING  
EXISTING



LEGEND

SPOT ELEVATION  
GROUND CONTOUR  
TREES AND SHRUBS  
MARSH  
EDGE OF WATER  
FENCE LINE  
RAILROAD TRACKS  
BUILDING  
MONITORING WELL LOCATION  
AND NUMBER  
W\_# # SHALLOW WELL  
W\_#B # INTERMEDIATE WELL  
W\_#C # DEEP WELL  
R = REPLACED WELL  
G\_## # GOVERNMENT WELL  
S = SHALLOW  
D = DEEP

Approved 1 Reference Revisions  
Developed

W38C PHASE 2 GROUNDWATER  
QUALITY BORING LOCATION  
AND NUMBER

— APPROXIMATE BELOIT CORPORATION PROPERTY LINE

— FOUNDRY SAND DISPOSAL AREA

— FIBROUS SLUDGE SPREADING AREA

██████ REMOVAL ACTION SITE BOUNDARY

EW04 PROPOSED GROUNDWATER EXTRACTION WELL LOCATION AND NUMBER  

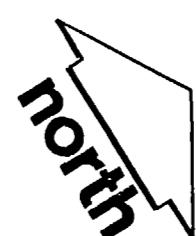

W45 PROPOSED MONITORING WELL TO BE INSTALLED DURING REMOVAL ACTION IMPLEMENTATION  


— PROPOSED LOCATION OF REMEDIATION SYSTEM PIPING

— UNDERGROUND POWER LINE

## NOTES

1. BASE MAP DEVELOPED FROM AN AERIAL SURVEY PERFORMED BY KBM, INC., GRAND FORKS, NORTH DAKOTA. DATE OF PHOTOGRAPHY: NOVEMBER 1990.
  2. ELEVATIONS ARE BASED ON U.S.G.S. DATUM (MEAN SEA LEVEL (MSL)).
  3. GRID BASED ON ILLINOIS STATE PLANE COORDINATE SYSTEM.



0 200  
  
SCALE IN FEET

## SITE FEATURES MAP

**REMOVAL ACTION DESIGN REPORT  
BELLOIT CORPORATION BLACKHAWK FACILITY  
SECTIONS 12 AND 13, T46N, R1E  
TOWNSHIP OF ROCKTON, WINNEBAGO COUNTY, ILLINOIS**

Drawing Number  
3856.0080 B1

**MONTGOMERY**

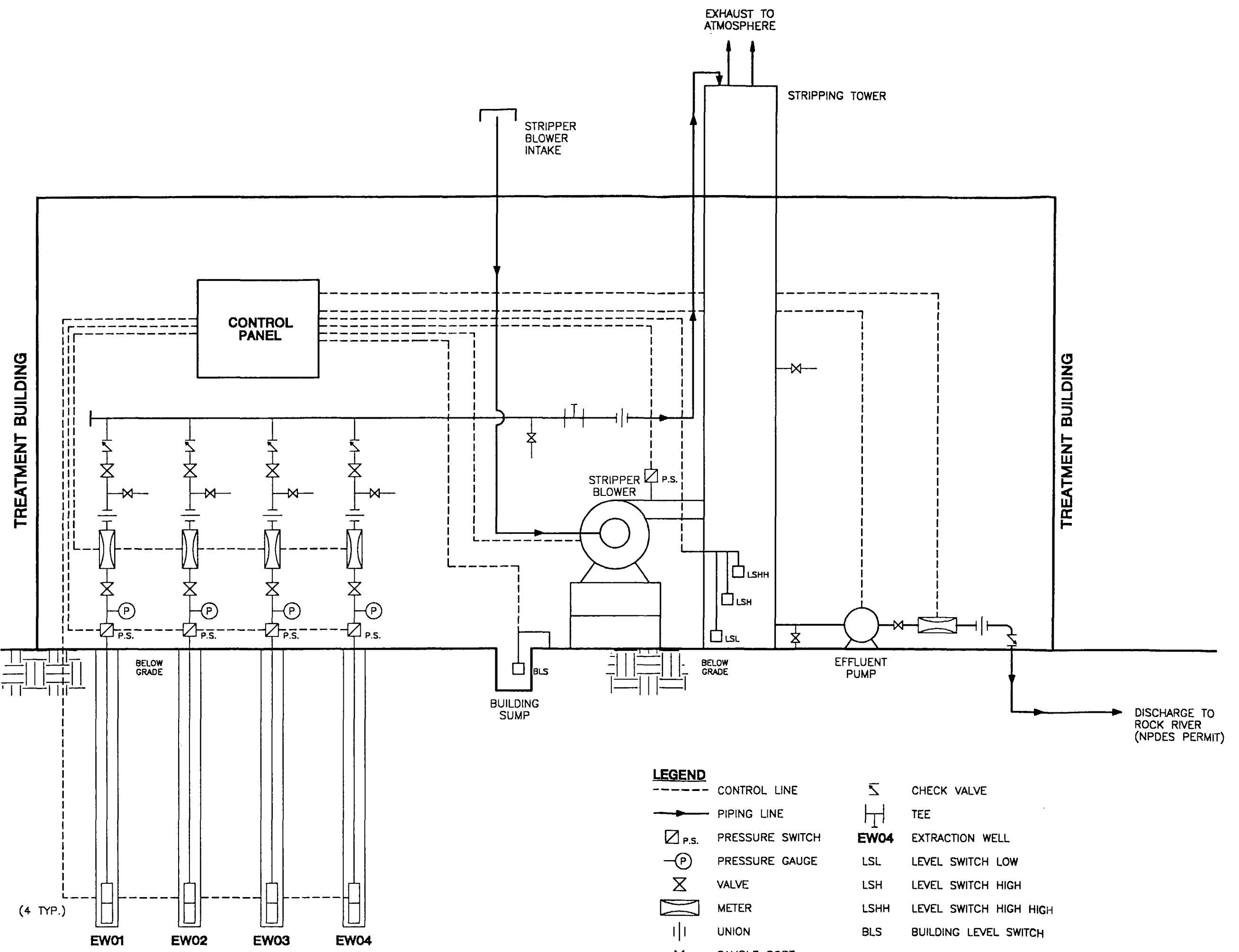
The Watson logo consists of the brand name "WATSON" in a bold, sans-serif font above a circular emblem. The emblem features a stylized profile of a human head facing left, with internal structures like the brain and ventricles visible, all enclosed within a circular border.

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

Graphic Standards CCM 06-15-95 Technical Review DJW 06-28-95 Management Review BN 06-16-95

Lead Professional CRM 06-15-95 Project Manager KJQ 06-29-95 Other

QUALITY CONTROL



NOT TO SCALE

**PROCESS FLOW DIAGRAM**

REMOVAL ACTION DESIGN REPORT  
BELOIT CORPORATION BLACKHAWK FACILITY  
SECTIONS 12 AND 13, T46N, R1E  
TOWN OF ROCKTON, WINNEBAGO COUNTY, ILLINOIS

Drawing Number  
3856.0080 B2

**MONTGOMERY WATSON**



Developed By CRM	Drawn By CCM,TMS
Approved By [Signature]	Date 11-11-92
Reference	Revisions

A

## GROUNDWATER FLOW MODEL

# A

## GROUNDWATER FLOW MODEL

The following is a description of the model input parameters and discussion of the rationale for the selection of those parameters. Also included in this appendix is a log file of the input parameters for the calibrated model run.

**Unit System:** English units (ft/gal/d)

**Grid Parameters:** The model grid is 51 by 64 lines. The grid spacing ranges from approximately 250 ft at the perimeter of the model to approximately 100 ft around the area of the plant.

**Boundary Conditions:** All of the model boundaries are simulated as no flow boundaries because the Rock River is present between the boundary and the site on the west, north and south boundaries, or because the existing groundwater flow is parallel to the model boundary (to the east). One constant head cell was needed to provide an initial head in the model. This was placed adjacent to the river, north of the site so it has very little if any influence on the model.

**Well Parameters:** No extraction wells are included in the calibration run.

**Specified Flux Nodes:** None

**Surface Water Bodies:** A total of 222 surface water nodes were designated. These nodes were located to simulate the Rock River. The heads at each node were based on known elevations from staff gauges and river elevations measured at the dams. The bottom elevation of the river was based on an assumption of a constant eight foot river depth along its entire length (although this has no affect on the simulations at this site). The leakage factors (river bed hydraulic conductivity/bed thickness) were based on an assumption that the river bed thickness and conductivity varies based on location. It was assumed that the nodes immediately upstream of a dam would have thicker river bottom sediments and lower

river bed conductivities. This assumption was necessary for model calibration. Values for the river bed conductances were based on literature<sup>1</sup>, Montgomery Watson experience, and calibration efforts. The values used, shown in the detailed printout, range from 0.0035 day<sup>-1</sup> near the dam to 0.283 day<sup>-1</sup> upstream of the site.

**Aquifer Properties:** Five different material property boxes were defined throughout the model (2 additional boxes were defined but not used in the final model). These areas and values are shown on Figure 2. Each box contains a designated aquifer hydraulic conductivity and effective porosity. The values for conductivity and porosity were obtained from data in Tech Memos I and II. Note that the designated values represent weighted averages for the entire vertical extent of the aquifer at each location (e.g., see Freeze and Cherry, 1979. Groundwater page 34). For example in the vicinity of well W23, there is a significant thickness of silty sand and relative thin zones of sand present above a high in the underlying clay. Therefore, the effective hydraulic conductivity of this area is less than to the south where the clay layer is lower and little silty sand is present (e.g., at W26C).

The porosity values used within each property box is based on the distribution of permeable sand units within the silty sand layer. The porosity was reduced to simulate the effective diffusivity (hydraulic conductivity/porosity) for each area. Where the hydraulic conductivity was reduced due to the presence of silty sand, the porosity was reduced as well, to maintain an equivalent value of diffusivity. The porosity value is not used in the solution for hydraulic heads because it is a steady state solution. Porosity is only used in estimating the capture zones.

**Aquifer Type:** Unconfined

**Aquifer Bottom Elevations:** The aquifer bottom elevation was designated as the top of the extensive clay unit identified at a depth of between 60 and 90 ft. Four zones of elevations were included to represent the higher elevation of the lower extensive clay unit beneath the plant. Values were used to simulate the top of clay shown in Drawing F6 presented in Technical Memorandum No. 2.

---

<sup>1</sup> General References:

Rorabaugh, M.I. 1951, Stream-Bed Percolation in Development of Water Supplies. Trans-General Assembly Brussels International Arrow Science Hydrology, V2 pp. 165-174.

Norris, S.E. and Eagon, H.B., Jr. 1971, Recharge Characteristics of a Water-Course Aquifer System at Springfield, Ohio, Groundwater V9 No. 1 pp. 30-41.

Warzyn Inc. 1986, Remedial Investigation of the Wausau Well Field.

**Areal Recharge:** An infiltration rate of 4 inches per year was assumed. This number is based on an average infiltration rate for a vegetated, non-sloping ground surface within the mid-west portion of the country.

## SENSITIVITY ANALYSIS

A sensitivity analysis was conducted to determine the range of potential responses to pumping the extraction wells. The parameters selected for this sensitivity analysis are those that would have the greatest affect on changes in hydraulic head. The parameters selected are the pumping rates, the hydraulic conductivity and the rainfall recharge to the aquifer. The results for each parameter are discussed below.

### Pumping Rates

The pumping rate sensitivity run for 50% decreased pumping produced a combined capture zone with insufficient capture between wells EW02 and EW04 (Figure 5). Pumping rates were 5 gpm at EW01, 12 gpm at EW02, 22 gpm at EW03, and 27 gpm at EW04. Insufficient capture also resulted in the area of the subdivision south of the Blackhawk plant. The pumping rate sensitivity run for maximized pumping used 10 gpm at EW01, 25 gpm at EW02, 70 gpm at EW03, and 100 gpm at EW04. This scenario produced similar capture on the removal action site as the base case, but had a minor increase in capture within the area of the subdivision (Figure 6). However, this increased capture may also result in the extraction of a significant volume of groundwater with no detectable VOCs.

### Hydraulic Conductivity

The sensitivity analysis for hydraulic conductivity (increased one order of magnitude and decreased on one-half order of magnitude) did not reflect observed groundwater levels. Figures 7 and 8 show, even with the simulated pumping wells, that the simulated groundwater levels are significantly different than observed conditions. This indicates that use of different hydraulic conductivities than those used in the calibrated model result in significantly different simulated water levels. Therefore, there is a low probability of these conditions being present. Regardless, the following is a discussion of the sensitivity runs. The high hydraulic conductivity scenario produced a combined capture zone that affected a significant area of uncontaminated groundwater upgradient of the site (Figure 7). The capture zone did not capture all of the area of contaminated on-site groundwater contamination and did not incorporate any of the subdivision area. The sensitivity analysis run for decreased hydraulic conductivity (decreased by one half order of magnitude) produced a slightly smaller combined capture zone and had less influence in the area of the subdivision (Figure 8). Pumping rates were not modified for either of the sensitivity runs for hydraulic conductivity.

### **Rainfall Recharge**

The sensitivity analysis for recharge did not reflect observed groundwater levels. Therefore, like the hydraulic conductivity sensitivity, indicates a low probability of these conditions being present. the increased recharge scenario (from 4 inches/yr to 8 inches/yr) resulted in a capture zone similar to the calibrated run (Figure 9). The sensitivity analysis for decreased recharge (decreased from 4 to 2 inches/yr) produced a combined capture zone that influenced a very large portion of uncontaminated aquifer, upgradient of the site (Figure 10). The resulting capture zone did not incorporate all of the contaminated aquifer between well EW02 and EW04. The resulting heads were significantly lower than the calibrated run. Pumping rates were not modified for either of the sensitivity runs for recharge.

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3856.0080-MD

## Water Balance Output

### Steady State - No Pumping

BEL13PR8.BAL

Global water balance [ft<sup>3</sup>/d] :

0.0000	total IN-flux through const. head nodes
-991.5980	total OUT-flux through const. head nodes
0.0000	total IN-flux through flux nodes
0.0000	total OUT-flux through flux nodes
128822.6595	total IN-flux through river nodes
-216695.3414	total OUT-flux through river nodes
0.0000	total IN-flux through drain nodes
0.0000	total OUT-flux through drain nodes
0.0000	total IN-flux through injection wells
0.0000	total OUT-flux through pumping wells
75078.6078	total net aquifer recharge
-13785.6721	sum of all fluxes should be zero
-3.2699%	total mass balance error

### Pumping Scenario - 140 gpm

BEL19.BAL

Global water balance [ft<sup>3</sup>/d] :

0.0000	total IN-flux through const. head nodes
-940.6403	total OUT-flux through const. head nodes
0.0000	total IN-flux through flux nodes
0.0000	total OUT-flux through flux nodes
149179.4348	total IN-flux through river nodes
-195881.9245	total OUT-flux through river nodes
0.0000	total IN-flux through drain nodes
0.0000	total OUT-flux through drain nodes
0.0000	total IN-flux through injection wells
-26953.9200	total OUT-flux through pumping wells
75078.6078	total net aquifer recharge
481.5578	sum of all fluxes should be zero
0.1075%	total mass balance error

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* E C H O P R I N T *  
*  
* F L O W P A T H *  
* version 5.0 *  
*  
* FLOWPATH was written by Thomas Franz and Nilson Guiguer *  
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* Waterloo Hydrogeologic Software *  
* 200 Candlewood Crescent *  
* Waterloo, Ontario *  
* N2L 5Y9, Canada *  
*  
* ph (519) 746-1798 *  
*  
*****
```

FLOWPATH logbook for data set : BEL13PR8

Unit System : English units [ft/gal/d]

\*\*\*\*\* GRID PARAMETERS \*\*\*\*\*

Number of x-grid lines : 51

Number of y-grid lines : 64

Grid coordinates (x-grid lines) [ft] :

1	0.000E+0000
2	2.410E+0002
3	4.821E+0002
4	7.231E+0002
5	9.641E+0002
6	1.205E+0003
7	1.446E+0003
8	1.687E+0003
9	1.928E+0003
10	2.169E+0003
11	2.410E+0003
12	2.651E+0003
13	2.892E+0003

14 3.133E+0003  
15 3.374E+0003  
16 3.497E+0003  
17 3.615E+0003  
18 3.736E+0003  
19 3.856E+0003  
20 3.981E+0003  
21 4.097E+0003  
22 4.205E+0003  
23 4.338E+0003  
24 4.450E+0003  
25 4.579E+0003  
26 4.695E+0003  
27 4.821E+0003  
28 4.941E+0003  
29 5.062E+0003  
30 5.168E+0003  
31 5.303E+0003  
32 5.412E+0003  
33 5.544E+0003  
34 5.657E+0003  
35 5.785E+0003  
36 5.905E+0003  
37 6.026E+0003  
38 6.267E+0003  
39 6.508E+0003  
40 6.749E+0003  
41 6.990E+0003  
42 7.231E+0003  
43 7.472E+0003  
44 7.713E+0003  
45 7.954E+0003  
46 8.195E+0003  
47 8.436E+0003  
48 8.677E+0003  
49 8.918E+0003  
50 9.159E+0003  
51 9.400E+0003

Grid coordinates (y-grid lines) [ft] :

1 0.000E+0000  
2 3.606E+0002  
3 6.934E+0002  
4 1.040E+0003  
5 1.364E+0003  
6 1.705E+0003  
7 2.046E+0003  
8 2.387E+0003  
9 2.728E+0003  
10 3.069E+0003  
11 3.410E+0003  
12 3.751E+0003  
13 4.004E+0003  
14 4.150E+0003

15	4.304E+0003
16	4.451E+0003
17	4.597E+0003
18	4.753E+0003
19	4.900E+0003
20	5.055E+0003
21	5.201E+0003
22	5.347E+0003
23	5.502E+0003
24	5.649E+0003
25	5.804E+0003
26	5.950E+0003
27	6.096E+0003
28	6.251E+0003
29	6.398E+0003
30	6.553E+0003
31	6.699E+0003
32	6.854E+0003
33	7.000E+0003
34	7.162E+0003
35	7.324E+0003
36	7.503E+0003
37	7.590E+0003
38	7.683E+0003
39	7.764E+0003
40	7.844E+0003
41	7.938E+0003
42	8.026E+0003
43	8.105E+0003
44	8.185E+0003
45	8.273E+0003
46	8.352E+0003
47	8.440E+0003
48	8.526E+0003
49	8.627E+0003
50	8.711E+0003
51	8.867E+0003
52	9.208E+0003
53	9.549E+0003
54	9.890E+0003
55	1.023E+0004
56	1.057E+0004
57	1.091E+0004
58	1.125E+0004
59	1.159E+0004
60	1.194E+0004
61	1.228E+0004
62	1.262E+0004
63	1.296E+0004
64	1.330E+0004

\*\*\*\*\* WELL PARAMETERS \*\*\*\*\*

Number of wells : 0

\*\*\*\*\* CONSTRAINED HEAD NODES \*\*\*\*\*

Number of constant head nodes : 1

No.	i	j	X [ft]	Y [ft]	const. head [ft]
1	50	63	9.149E+0003	1.297E+0004	7.255E+0002

\*\*\*\*\* SPECIFIED FLUX NODES \*\*\*\*\*

Number of flux nodes : 0

\*\*\*\*\* SURFACE WATER BODIES \*\*\*\*\*

Number of surface water body nodes : 222

No.	i	j	X [ft]	Y [ft]	water table [ft]	bottom elevation [ft]	leakage factor [ft/d]
1	48	63	8.7E+0003	1.3E+0004	7.3E+0002	7.2E+0002	1.42E-0001
2	47	62	8.4E+0003	1.3E+0004	7.3E+0002	7.2E+0002	1.42E-0001
3	47	61	8.4E+0003	1.2E+0004	7.3E+0002	7.2E+0002	1.42E-0001
4	47	60	8.4E+0003	1.2E+0004	7.3E+0002	7.2E+0002	1.42E-0001
5	46	60	8.2E+0003	1.2E+0004	7.3E+0002	7.2E+0002	1.42E-0001
6	46	59	8.2E+0003	1.2E+0004	7.3E+0002	7.2E+0002	1.42E-0001
7	45	59	8.0E+0003	1.2E+0004	7.3E+0002	7.2E+0002	1.42E-0001
8	44	58	7.7E+0003	1.1E+0004	7.3E+0002	7.2E+0002	1.42E-0001
9	43	58	7.5E+0003	1.1E+0004	7.3E+0002	7.2E+0002	1.42E-0001
10	43	57	7.5E+0003	1.1E+0004	7.3E+0002	7.2E+0002	1.42E-0001
11	42	57	7.2E+0003	1.1E+0004	7.3E+0002	7.2E+0002	1.42E-0001
12	41	57	7.0E+0003	1.1E+0004	7.3E+0002	7.2E+0002	1.42E-0001
13	41	56	7.0E+0003	1.1E+0004	7.3E+0002	7.2E+0002	1.42E-0001
14	40	56	6.8E+0003	1.1E+0004	7.3E+0002	7.2E+0002	1.42E-0001
15	40	57	6.8E+0003	1.1E+0004	7.3E+0002	7.2E+0002	1.42E-0001
16	39	56	6.5E+0003	1.1E+0004	7.3E+0002	7.2E+0002	1.42E-0001
17	39	55	6.5E+0003	1.0E+0004	7.3E+0002	7.2E+0002	1.42E-0001
18	38	55	6.3E+0003	1.0E+0004	7.3E+0002	7.2E+0002	1.42E-0001
19	38	56	6.3E+0003	1.1E+0004	7.3E+0002	7.2E+0002	1.42E-0001
20	37	55	6.0E+0003	1.0E+0004	7.3E+0002	7.2E+0002	1.42E-0001
21	35	54	5.8E+0003	9.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001
22	33	54	5.5E+0003	9.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001
23	31	53	5.3E+0003	9.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
24	31	54	5.3E+0003	9.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001

25	29	53	5.1E+0003	9.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
26	27	53	4.8E+0003	9.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
27	27	52	4.8E+0003	9.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
28	25	52	4.6E+0003	9.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
29	25	53	4.6E+0003	9.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
30	25	54	4.6E+0003	9.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001
31	23	54	4.3E+0003	9.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001
32	23	52	4.3E+0003	9.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
33	21	52	4.1E+0003	9.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
34	21	53	4.1E+0003	9.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
35	21	54	4.1E+0003	9.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001
36	19	53	3.9E+0003	9.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
37	19	52	3.9E+0003	9.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
38	17	52	3.6E+0003	9.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
39	15	52	3.4E+0003	9.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
40	14	52	3.1E+0003	9.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
41	14	51	3.1E+0003	8.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001
42	13	51	2.9E+0003	8.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001
43	12	48	2.7E+0003	8.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
44	12	44	2.7E+0003	8.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
45	11	48	2.4E+0003	8.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
46	11	44	2.4E+0003	8.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
47	11	40	2.4E+0003	7.8E+0003	7.3E+0002	7.2E+0002	1.42E-0001
48	10	40	2.2E+0003	7.8E+0003	7.3E+0002	7.2E+0002	1.42E-0001
49	10	36	2.2E+0003	7.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
50	11	36	2.4E+0003	7.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
51	10	34	2.2E+0003	7.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
52	11	32	2.4E+0003	6.8E+0003	7.3E+0002	7.2E+0002	1.42E-0001
53	11	29	2.4E+0003	6.5E+0003	7.3E+0002	7.2E+0002	3.50E-0003
54	12	29	2.7E+0003	6.5E+0003	7.3E+0002	7.2E+0002	3.50E-0003
55	12	27	2.7E+0003	6.1E+0003	7.3E+0002	7.2E+0002	3.50E-0003
56	13	27	2.9E+0003	6.1E+0003	7.3E+0002	7.2E+0002	3.50E-0003
57	13	25	2.9E+0003	5.8E+0003	7.3E+0002	7.2E+0002	3.50E-0003
58	13	23	2.9E+0003	5.5E+0003	7.3E+0002	7.2E+0002	3.50E-0003
59	12	23	2.7E+0003	5.5E+0003	7.3E+0002	7.2E+0002	3.50E-0003
60	12	20	2.7E+0003	5.1E+0003	7.3E+0002	7.2E+0002	3.50E-0003
61	11	18	2.4E+0003	4.8E+0003	7.3E+0002	7.2E+0002	3.50E-0003
62	10	18	2.2E+0003	4.8E+0003	7.3E+0002	7.2E+0002	3.50E-0003
63	9	18	1.9E+0003	4.8E+0003	7.3E+0002	7.2E+0002	3.50E-0003
64	8	18	1.7E+0003	4.8E+0003	7.3E+0002	7.2E+0002	3.50E-0003
65	7	18	1.4E+0003	4.8E+0003	7.3E+0002	7.2E+0002	3.50E-0003
66	6	18	1.2E+0003	4.8E+0003	7.3E+0002	7.2E+0002	3.50E-0003
67	6	20	1.2E+0003	5.1E+0003	7.3E+0002	7.2E+0002	3.50E-0003
68	6	23	1.2E+0003	5.5E+0003	7.3E+0002	7.2E+0002	3.50E-0003
69	5	23	9.6E+0002	5.5E+0003	7.3E+0002	7.2E+0002	3.50E-0003
70	5	25	9.6E+0002	5.8E+0003	7.3E+0002	7.2E+0002	3.50E-0003
71	4	25	7.2E+0002	5.8E+0003	7.3E+0002	7.2E+0002	3.50E-0003
72	4	27	7.2E+0002	6.1E+0003	7.3E+0002	7.2E+0002	3.50E-0003
73	3	27	4.9E+0002	6.1E+0003	7.3E+0002	7.2E+0002	1.42E-0001
74	2	29	2.4E+0002	6.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
75	1	27	0.0E+0000	6.1E+0003	7.3E+0002	7.2E+0002	1.42E-0001
76	5	16	9.6E+0002	4.4E+0003	7.3E+0002	7.2E+0002	3.50E-0003
77	4	16	7.2E+0002	4.4E+0003	7.3E+0002	7.2E+0002	3.50E-0003
78	3	14	4.9E+0002	4.1E+0003	7.3E+0002	7.2E+0002	3.50E-0003
79	3	12	4.8E+0002	3.8E+0003	7.3E+0002	7.2E+0002	3.50E-0003
80	4	11	7.2E+0002	3.4E+0003	7.3E+0002	7.2E+0002	3.50E-0003

81	5	10	9.6E+0002	3.1E+0003	7.3E+0002	7.2E+0002	3.50E-0003
82	6	9	1.2E+0003	2.7E+0003	7.3E+0002	7.2E+0002	3.50E-0003
83	7	9	1.4E+0003	2.7E+0003	7.3E+0002	7.2E+0002	3.50E-0003
84	8	9	1.7E+0003	2.7E+0003	7.3E+0002	7.2E+0002	1.42E-0001
85	9	8	1.9E+0003	2.4E+0003	7.3E+0002	7.2E+0002	1.42E-0001
86	10	7	2.2E+0003	2.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
87	11	7	2.4E+0003	2.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
88	3	13	4.8E+0002	4.0E+0003	7.3E+0002	7.2E+0002	3.50E-0003
89	4	15	7.2E+0002	4.3E+0003	7.3E+0002	7.2E+0002	3.50E-0003
90	12	21	2.7E+0003	5.2E+0003	7.3E+0002	7.2E+0002	3.50E-0003
91	12	22	2.7E+0003	5.3E+0003	7.3E+0002	7.2E+0002	3.50E-0003
92	12	24	2.7E+0003	5.6E+0003	7.3E+0002	7.2E+0002	3.50E-0003
93	12	25	2.7E+0003	5.8E+0003	7.3E+0002	7.2E+0002	3.50E-0003
94	15	5	3.4E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
95	16	5	3.5E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
96	17	5	3.6E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
97	14	5	3.1E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
98	12	26	2.7E+0003	5.9E+0003	7.3E+0002	7.2E+0002	3.50E-0003
99	12	28	2.7E+0003	6.2E+0003	7.3E+0002	7.2E+0002	3.50E-0003
100	13	28	2.9E+0003	6.2E+0003	7.3E+0002	7.2E+0002	3.50E-0003
101	11	20	2.4E+0003	5.1E+0003	7.3E+0002	7.2E+0002	3.50E-0003
102	2	29	2.4E+0002	6.4E+0003	7.3E+0002	7.2E+0002	1.42E-0001
103	3	30	4.9E+0002	6.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
104	3	29	4.9E+0002	6.4E+0003	7.3E+0002	7.2E+0002	1.42E-0001
105	3	28	4.9E+0002	6.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
106	4	26	7.2E+0002	5.9E+0003	7.3E+0002	7.2E+0002	3.50E-0003
107	5	24	9.6E+0002	5.6E+0003	7.3E+0002	7.2E+0002	3.50E-0003
108	11	19	2.4E+0003	4.9E+0003	7.3E+0002	7.2E+0002	3.50E-0003
109	10	17	2.2E+0003	4.6E+0003	7.3E+0002	7.2E+0002	3.50E-0003
110	9	17	1.9E+0003	4.6E+0003	7.3E+0002	7.2E+0002	3.50E-0003
111	6	22	1.2E+0003	5.3E+0003	7.3E+0002	7.2E+0002	3.50E-0003
112	7	21	1.4E+0003	5.2E+0003	7.3E+0002	7.2E+0002	3.50E-0003
113	6	21	1.2E+0003	5.2E+0003	7.3E+0002	7.2E+0002	3.50E-0003
114	7	20	1.4E+0003	5.1E+0003	7.3E+0002	7.2E+0002	3.50E-0003
115	7	19	1.4E+0003	4.9E+0003	7.3E+0002	7.2E+0002	3.50E-0003
116	7	17	1.4E+0003	4.6E+0003	7.3E+0002	7.2E+0002	3.50E-0003
117	8	17	1.7E+0003	4.6E+0003	7.3E+0002	7.2E+0002	3.50E-0003
118	17	4	3.6E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
119	16	4	3.5E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
120	15	4	3.4E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
121	14	4	3.1E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
122	13	4	2.9E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
123	12	4	2.7E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
124	11	4	2.4E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
125	10	5	2.2E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
126	11	5	2.4E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
127	8	5	1.7E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
128	9	5	1.9E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
129	7	4	1.4E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
130	7	5	1.4E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
131	6	5	1.2E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
132	6	4	1.2E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
133	5	4	9.6E+0002	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
134	5	5	9.6E+0002	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
135	4	5	7.2E+0002	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
136	3	5	4.8E+0002	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001

137	2	5	2.4E+0002	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
138	1	5	0.0E+0000	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
139	1	6	0.0E+0000	1.7E+0003	7.1E+0002	7.1E+0002	2.83E-0001
140	13	5	2.9E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
141	12	6	2.7E+0003	1.7E+0003	7.1E+0002	7.1E+0002	2.83E-0001
142	13	29	2.9E+0003	6.4E+0003	7.3E+0002	7.2E+0002	3.50E-0003
143	12	29	2.7E+0003	6.4E+0003	7.3E+0002	7.2E+0002	1.42E-0001
144	11	29	2.4E+0003	6.4E+0003	7.3E+0002	7.2E+0002	1.42E-0001
145	12	31	2.7E+0003	6.7E+0003	7.3E+0002	7.2E+0002	1.42E-0001
146	16	52	3.5E+0003	9.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
147	12	50	2.7E+0003	8.7E+0003	7.3E+0002	7.2E+0002	1.42E-0001
148	13	50	2.9E+0003	8.7E+0003	7.3E+0002	7.2E+0002	1.42E-0001
149	12	49	2.7E+0003	8.6E+0003	7.3E+0002	7.2E+0002	1.42E-0001
150	12	47	2.7E+0003	8.4E+0003	7.3E+0002	7.2E+0002	1.42E-0001
151	11	47	2.4E+0003	8.4E+0003	7.3E+0002	7.2E+0002	1.42E-0001
152	11	46	2.4E+0003	8.4E+0003	7.3E+0002	7.2E+0002	1.42E-0001
153	11	45	2.4E+0003	8.3E+0003	7.3E+0002	7.2E+0002	1.42E-0001
154	12	45	2.7E+0003	8.3E+0003	7.3E+0002	7.2E+0002	1.42E-0001
155	12	46	2.7E+0003	8.4E+0003	7.3E+0002	7.2E+0002	1.42E-0001
156	11	43	2.4E+0003	8.1E+0003	7.3E+0002	7.2E+0002	1.42E-0001
157	11	42	2.4E+0003	8.0E+0003	7.3E+0002	7.2E+0002	1.42E-0001
158	11	41	2.4E+0003	7.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001
159	10	41	2.2E+0003	7.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001
160	10	39	2.2E+0003	7.8E+0003	7.3E+0002	7.2E+0002	1.42E-0001
161	11	39	2.4E+0003	7.8E+0003	7.3E+0002	7.2E+0002	1.42E-0001
162	11	38	2.4E+0003	7.7E+0003	7.3E+0002	7.2E+0002	1.42E-0001
163	10	38	2.2E+0003	7.7E+0003	7.3E+0002	7.2E+0002	1.42E-0001
164	10	37	2.2E+0003	7.6E+0003	7.3E+0002	7.2E+0002	1.42E-0001
165	10	35	2.2E+0003	7.3E+0003	7.3E+0002	7.2E+0002	1.42E-0001
166	10	33	2.2E+0003	7.0E+0003	7.3E+0002	7.2E+0002	1.42E-0001
167	11	33	2.4E+0003	7.0E+0003	7.3E+0002	7.2E+0002	1.42E-0001
168	11	31	2.4E+0003	6.7E+0003	7.3E+0002	7.2E+0002	1.42E-0001
169	18	5	3.7E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
170	18	4	3.7E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
171	19	4	3.9E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
172	19	5	3.9E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
173	20	5	4.0E+0003	1.4E+0003	7.1E+0002	7.1E+0002	2.83E-0001
174	20	4	4.0E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
175	21	4	4.1E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
176	22	4	4.2E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
177	23	4	4.3E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
178	24	4	4.5E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
179	25	4	4.6E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
180	26	4	4.7E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
181	25	3	4.6E+0003	6.9E+0002	7.1E+0002	7.1E+0002	2.83E-0001
182	26	3	4.7E+0003	6.9E+0002	7.1E+0002	7.1E+0002	2.83E-0001
183	27	3	4.8E+0003	6.9E+0002	7.1E+0002	7.1E+0002	2.83E-0001
184	28	3	4.9E+0003	6.9E+0002	7.1E+0002	7.1E+0002	2.83E-0001
185	29	3	5.1E+0003	6.9E+0002	7.1E+0002	7.1E+0002	2.83E-0001
186	27	4	4.8E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
187	28	4	4.9E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
188	29	4	5.1E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
189	30	4	5.2E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
190	31	4	5.3E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
191	32	4	5.4E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
192	33	4	5.5E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001

193	34	4	5.7E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
194	35	4	5.8E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
195	36	4	5.9E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
196	37	4	6.0E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
197	38	4	6.3E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
198	39	4	6.5E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
199	40	4	6.8E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
200	41	4	7.0E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
201	42	4	7.2E+0003	1.0E+0003	7.1E+0002	7.1E+0002	2.83E-0001
202	42	3	7.2E+0003	6.9E+0002	7.1E+0002	7.1E+0002	2.83E-0001
203	43	3	7.5E+0003	6.9E+0002	7.1E+0002	7.1E+0002	2.83E-0001
204	43	2	7.5E+0003	3.6E+0002	7.1E+0002	7.1E+0002	2.83E-0001
205	44	2	7.7E+0003	3.6E+0002	7.1E+0002	7.1E+0002	2.83E-0001
206	44	1	7.7E+0003	0.0E+0000	7.1E+0002	7.1E+0002	2.83E-0001
207	45	1	8.0E+0003	0.0E+0000	7.1E+0002	7.1E+0002	2.83E-0001
208	13	30	2.9E+0003	6.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
209	13	31	2.9E+0003	6.7E+0003	7.3E+0002	7.2E+0002	1.42E-0001
210	13	32	2.9E+0003	6.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001
211	14	33	3.1E+0003	7.0E+0003	7.3E+0002	7.2E+0002	1.42E-0001
212	14	34	3.1E+0003	7.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001
213	14	35	3.1E+0003	7.3E+0003	7.3E+0002	7.2E+0002	1.42E-0001
214	15	36	3.4E+0003	7.5E+0003	7.3E+0002	7.2E+0002	1.42E-0001
215	15	37	3.4E+0003	7.6E+0003	7.3E+0002	7.2E+0002	1.42E-0001
216	15	38	3.4E+0003	7.7E+0003	7.3E+0002	7.2E+0002	1.42E-0001
217	15	39	3.4E+0003	7.8E+0003	7.3E+0002	7.2E+0002	1.42E-0001
218	15	40	3.4E+0003	7.8E+0003	7.3E+0002	7.2E+0002	1.42E-0001
219	15	41	3.4E+0003	7.9E+0003	7.3E+0002	7.2E+0002	1.42E-0001
220	14	42	3.1E+0003	8.0E+0003	7.3E+0002	7.2E+0002	1.42E-0001
221	14	43	3.1E+0003	8.1E+0003	7.3E+0002	7.2E+0002	1.42E-0001
222	14	44	3.1E+0003	8.2E+0003	7.3E+0002	7.2E+0002	1.42E-0001

\*\*\*\*\* AQUIFER PROPERTIES \*\*\*\*\*

Number of different material properties : 7

No.	Kxx [ft/d]	Kyy [ft/d]	Porosity [-]	
1	5.669E+0001	5.669E+0001	3.000E-0001	(default)
2	2.830E+0001	2.830E+0001	2.400E-0001	
3	5.100E+0000	5.100E+0000	6.000E-0002	
4	3.120E+0000	3.120E+0000	1.500E-0002	
5	1.700E+0002	1.700E+0002	3.000E-0001	
6	1.420E-0001	1.420E-0001	3.000E-0001	
7	5.669E-0001	5.669E-0001	1.500E-0002	

\*\*\*\*\* DISTRIBUTION OF AQUIFER MATERIAL PROPERTIES \*\*\*\*\*

| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17



8	*	*	*	*	*	*	*	*	5	5	5	5	5	5	5	5
7	*	*	*	*	*	*	*	*	5	5	5	5	5	5	5	5
6	5	5	*	*	*	*	*	*	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
4	*	*	5	5	5	5	5	5	5	5	5	5	5	5	5	5
3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

| 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

64	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
63	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
62	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
61	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
60	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
59	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
58	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
57	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
56	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
55	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
54	*	1	1	1	1	1	1	1	1	1	4	4	4	4	4	4
53	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
52	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
51	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
50	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
49	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
48	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
47	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
46	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
45	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
44	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
43	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
42	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3
41	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3
40	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3
39	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3
38	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3
37	4	4	4	4	4	4	4	4	4	3	3	7	7	3	3	3
36	4	4	4	4	4	4	4	4	4	3	3	7	7	3	3	3
35	4	4	4	4	4	4	4	4	4	3	3	7	7	3	3	3
34	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
33	1	3	3	3	3	3	3	3	7	7	7	3	3	3	3	3
32	1	3	3	3	3	3	3	3	7	7	7	7	3	3	3	3
31	1	3	3	3	3	3	3	3	7	7	7	7	3	3	3	3
30	1	1	1	1	1	1	1	7	7	7	7	7	3	3	3	3
29	1	1	1	1	1	1	1	7	7	7	7	7	3	3	3	3
28	1	1	1	1	1	1	1	3	3	3	3	3	3	3	3	3
27	1	1	1	1	1	1	1	1	3	3	3	3	3	3	3	3
26	1	1	1	1	1	1	1	1	3	3	3	3	3	3	3	3
25	5	5	5	5	5	5	5	5	5	5	5	5	5	3	3	3
24	5	5	5	5	5	5	5	5	5	5	5	5	3	3	3	3
23	5	5	5	5	5	5	5	5	5	5	5	5	3	3	3	3

| 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

| 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51

36	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
35	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
34	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
33	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
32	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
31	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
30	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
29	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
28	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
27	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
26	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	3	3	3	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5
24	3	3	3	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5
23	3	3	3	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5
22	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
21	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
20	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
19	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
18	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
17	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
16	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
15	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
14	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
13	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
12	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
11	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
10	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
9	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
8	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
7	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
2	*	*	*	*	*	*	*	*	5	5	5	5	5	5	5	5	5	
1	*	*	*	*	*	*	*	*	5	5	5	5	5	5	5	5	5	

| 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51

#### \*\*\*\*\* AQUIFER TYPE \*\*\*\*\*

Unconfined aquifer

#### \*\*\*\*\* AQUIFER BOTTOM ELEVATIONS \*\*\*\*\*

Number of different aquifer bottom elevations : 4

No. aquifer bottom elevation

[ft]

1	6.600E+0002 (default)
2	6.700E+0002
3	6.800E+0002
4	6.900E+0002

\*\*\*\*\* DISTRIBUTION OF AQUIFER BOTTOM ELEVATIONS \*\*\*\*\*

| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

21	*	*	*	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1
20	*	*	*	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1
19	*	*	*	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1
18	*	*	*	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1
17	*	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	*	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	*	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	*	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	*	*	*	*	*	*	1	1	1	1	1	1	1	1	1	1	1	1
8	*	*	*	*	*	*	*	1	1	1	1	1	1	1	1	1	1	1
7	*	*	*	*	*	*	*	*	1	1	1	1	1	1	1	1	1	1
6	1	1	*	*	*	*	*	*	*	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

| 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

64	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
63	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
62	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
61	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
60	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
59	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
58	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
57	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
56	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
55	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
54	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
53	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
52	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
51	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
50	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
49	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
48	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
47	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
46	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
45	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
44	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
43	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
42	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
41	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
40	2	2	2	3	3	3	4	4	4	4	4	4	4	4	3	3	3	3
39	2	2	2	3	3	3	4	4	4	4	4	4	4	4	3	3	3	3
38	2	2	2	3	3	3	4	4	4	4	4	4	4	4	3	3	3	3
37	2	2	2	3	3	3	4	4	4	4	4	4	4	4	3	3	3	3
36	2	2	2	3	3	3	4	4	4	4	4	4	4	4	3	3	3	3
35	2	2	2	3	3	3	4	4	4	4	4	4	4	3	3	3	3	3

| 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

| 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51

47	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
46	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
45	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
44	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
43	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
42	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
41	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
40	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
39	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
38	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
37	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
36	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
35	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
34	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
33	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
32	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
31	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
28	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
27	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
8	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
7	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
6	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

| 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51

\*\*\*\*\* AREAL RECHARGE \*\*\*\*\*

Number of different infiltration/evapotranspiration rates : 1

No. infiltration evapotranspiration effective recharge  
 [L/T] [L/T] [L/T]

1 9.130E-0004 0.000E+0000 9.130E-0004 (default)

\*\*\*\*\* DISTRIBUTION OF AREAL IN/OUT-FUXES \*\*\*\*\*

| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17



| 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

| 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51

47	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
46	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
45	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
44	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
43	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
42	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
41	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
40	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
39	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
38	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
37	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
36	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
35	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
34	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
33	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
32	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
31	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
28	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
27	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
8	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
7	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
6	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

| 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51

\*\*\*\*\* PATHLINE & PARTICLE TRACKING DATA \*\*\*\*\*

Number of forward particles : 20

No. x-release y-release

1	4.650E+0003	8.017E+0003
2	4.679E+0003	8.017E+0003
3	4.708E+0003	8.017E+0003
4	4.731E+0003	8.017E+0003
5	4.754E+0003	8.017E+0003
6	4.754E+0003	7.994E+0003
7	4.754E+0003	7.965E+0003
8	4.754E+0003	7.931E+0003
9	4.754E+0003	7.902E+0003
10	4.754E+0003	7.868E+0003
11	4.731E+0003	7.868E+0003
12	4.702E+0003	7.868E+0003
13	4.673E+0003	7.868E+0003
14	4.645E+0003	7.868E+0003
15	4.622E+0003	7.868E+0003
16	4.622E+0003	7.896E+0003
17	4.622E+0003	7.931E+0003
18	4.622E+0003	7.959E+0003
19	4.622E+0003	7.988E+0003
20	4.622E+0003	8.017E+0003

Number of reverse particles : 0

No well particles specified

\*\*\*\*\* HYDRAULIC HEAD DISTRIBUTION \*\*\*\*\*

	1	2	3	4	5	6
64	*	*	*	*	*	*
63	*	*	*	*	*	*
62	*	*	*	*	*	*
61	*	*	*	*	*	*
60	*	*	*	*	*	*
59	*	*	*	*	*	*
58	*	*	*	*	*	*
57	*	*	*	*	*	*
56	*	*	*	*	*	*
55	*	*	*	*	*	*
54	*	*	*	*	*	*
53	*	*	*	*	*	*
52	*	*	*	*	*	*
51	*	*	*	*	*	*
50	*	*	*	*	*	*
49	*	*	*	*	*	*
48	*	*	*	*	*	*

47	*	*	*	*	*	*
46	*	*	*	*	*	*
45	*	*	*	*	*	*
44	*	*	*	*	*	*
43	*	*	*	*	*	*
42	*	*	*	*	*	*
41	*	*	*	*	*	*
40	*	*	*	*	*	*
39	*	*	*	*	*	*
38	*	*	*	*	*	*
37	*	*	*	*	*	*
36	*	*	*	*	*	*
35	*	*	*	*	*	*
34	*	*	*	*	*	*
33	*	*	*	*	*	*
32	*	*	*	*	*	*
31	*	*	*	*	*	*
30	*	7.25E+0002	7.25E+0002	*	*	*
29	7.25E+0002	7.25E+0002	7.25E+0002	7.25E+0002	*	*
28	7.25E+0002	7.25E+0002	7.25E+0002	7.25E+0002	7.24E+0002	7.24E+0002
27	7.25E+0002	7.25E+0002	7.25E+0002	7.24E+0002	7.24E+0002	7.24E+0002
26	*	*	*	7.24E+0002	7.24E+0002	7.23E+0002
25	*	*	*	7.24E+0002	7.24E+0002	7.23E+0002
24	*	*	*	7.24E+0002	7.23E+0002	7.23E+0002
23	*	*	*	*	7.23E+0002	7.23E+0002
22	*	*	*	*	7.23E+0002	7.23E+0002
21	*	*	*	*	*	7.23E+0002
20	*	*	*	*	*	7.23E+0002
19	*	*	*	*	*	7.23E+0002
18	*	*	*	*	*	7.23E+0002
17	*	*	*	7.22E+0002	7.22E+0002	7.23E+0002
16	*	*	*	7.22E+0002	7.22E+0002	7.22E+0002
15	*	*	7.22E+0002	7.22E+0002	7.22E+0002	7.22E+0002
14	*	*	7.22E+0002	7.22E+0002	7.22E+0002	7.22E+0002
13	*	*	7.22E+0002	7.22E+0002	7.22E+0002	7.22E+0002
12	*	*	7.22E+0002	7.22E+0002	7.22E+0002	7.22E+0002
11	*	*	*	7.22E+0002	7.22E+0002	7.22E+0002
10	*	*	*	7.22E+0002	7.22E+0002	7.22E+0002
9	*	*	*	*	*	*
8	*	*	*	*	*	*
7	*	*	*	*	*	*
6	7.13E+0002	7.13E+0002	*	*	*	*
5	7.13E+0002	7.13E+0002	7.13E+0002	7.13E+0002	7.13E+0002	7.13E+0002
4	*	*	7.13E+0002	7.13E+0002	7.13E+0002	7.13E+0002
3	*	*	*	*	*	*
2	*	*	*	*	*	*
1	*	*	*	*	*	*

	1	2	3	4	5	6
--	---	---	---	---	---	---

	7	8	9	10	11	12
--	---	---	---	----	----	----

64	*	*	*	*	*	*
63	*	*	*	*	*	*
62	*	*	*	*	*	*
61	*	*	*	*	*	*







	19	20	21	22	23	24
	25	26	27	28	29	30

64	*	*	*	*	*	*
63	*	*	*	*	*	*
62	*	*	*	*	*	*
61	*	*	*	*	*	*
60	*	*	*	*	*	*
59	*	*	*	*	*	*
58	*	*	*	*	*	*
57	*	*	*	*	*	*
56	*	*	*	*	*	*
55	*	*	*	*	*	*
54	7.26E+0002	7.26E+0002	7.26E+0002	7.26E+0002	7.26E+0002	7.26E+0002
53	7.26E+0002	7.26E+0002	7.26E+0002	7.26E+0002	7.26E+0002	7.26E+0002
52	7.26E+0002	7.26E+0002	7.26E+0002	7.26E+0002	7.27E+0002	7.27E+0002
51	7.27E+0002	7.27E+0002	7.27E+0002	7.28E+0002	7.28E+0002	7.28E+0002
50	7.28E+0002	7.28E+0002	7.28E+0002	7.28E+0002	7.28E+0002	7.29E+0002
49	7.28E+0002	7.28E+0002	7.28E+0002	7.28E+0002	7.29E+0002	7.29E+0002
48	7.28E+0002	7.28E+0002	7.28E+0002	7.29E+0002	7.29E+0002	7.29E+0002
47	7.28E+0002	7.28E+0002	7.28E+0002	7.29E+0002	7.29E+0002	7.29E+0002
46	7.28E+0002	7.28E+0002	7.29E+0002	7.29E+0002	7.29E+0002	7.29E+0002
45	7.28E+0002	7.28E+0002	7.29E+0002	7.29E+0002	7.29E+0002	7.29E+0002
44	7.28E+0002	7.28E+0002	7.29E+0002	7.29E+0002	7.29E+0002	7.29E+0002

| 25 26 27 28 29 30

31 32 33 34 35 36

64	*	*	*	*	*	*
63	*	*	*	*	*	*
62	*	*	*	*	*	*
61	*	*	*	*	*	*
60	*	*	*	*	*	*
59	*	*	*	*	*	*
58	*	*	*	*	*	*
57	*	*	*	*	*	*







	43	44	45	46	47	48
	49	50	51			
64	7.26E+0002	7.26E+0002	7.26E+0002			
63	7.26E+0002	7.26E+0002	7.26E+0002			
62	7.26E+0002	7.26E+0002	7.26E+0002			
61	7.26E+0002	7.26E+0002	7.26E+0002			
60	7.26E+0002	7.26E+0002	7.26E+0002			
59	7.27E+0002	7.27E+0002	7.27E+0002			
58	7.28E+0002	7.28E+0002	7.28E+0002			
7	7.28E+0002	7.28E+0002	7.28E+0002			
6	7.29E+0002	7.29E+0002	7.29E+0002			
55	7.29E+0002	7.29E+0002	7.29E+0002			
44	7.29E+0002	7.29E+0002	7.29E+0002			
33	7.30E+0002	7.29E+0002	7.29E+0002			
22	7.30E+0002	7.29E+0002	7.29E+0002			
11	7.29E+0002	7.29E+0002	7.29E+0002			
0	7.29E+0002	7.29E+0002	7.29E+0002			
9	7.29E+0002	7.29E+0002	7.29E+0002			
8	7.29E+0002	7.29E+0002	7.29E+0002			
7	7.29E+0002	7.29E+0002	7.28E+0002			
6	7.29E+0002	7.29E+0002	7.28E+0002			
5	7.29E+0002	7.28E+0002	7.28E+0002			
4	7.29E+0002	7.28E+0002	7.28E+0002			
3	7.28E+0002	7.28E+0002	7.28E+0002			
2	7.28E+0002	7.28E+0002	7.28E+0002			
1	7.28E+0002	7.28E+0002	7.27E+0002			
0	7.28E+0002	7.28E+0002	7.27E+0002			

39		7.28E+0002	7.27E+0002	7.27E+0002
38		7.27E+0002	7.27E+0002	7.27E+0002
37		7.27E+0002	7.27E+0002	7.27E+0002
36		7.27E+0002	7.27E+0002	7.26E+0002
35		7.26E+0002	7.26E+0002	7.26E+0002
34		7.26E+0002	7.25E+0002	7.25E+0002
33		7.25E+0002	7.25E+0002	7.25E+0002
32		7.24E+0002	7.24E+0002	7.24E+0002
31		7.24E+0002	7.23E+0002	7.23E+0002
30		7.23E+0002	7.23E+0002	7.23E+0002
29		7.22E+0002	7.22E+0002	7.22E+0002
28		7.21E+0002	7.21E+0002	7.21E+0002
27		7.20E+0002	7.20E+0002	7.21E+0002
26		7.19E+0002	7.20E+0002	7.20E+0002
25		7.19E+0002	7.19E+0002	7.19E+0002
24		7.19E+0002	7.19E+0002	7.19E+0002
23		7.19E+0002	7.19E+0002	7.19E+0002
22		7.19E+0002	7.19E+0002	7.19E+0002
21		7.19E+0002	7.19E+0002	7.19E+0002
20		7.19E+0002	7.19E+0002	7.19E+0002
19		7.19E+0002	7.19E+0002	7.19E+0002
18		7.19E+0002	7.19E+0002	7.19E+0002
17		7.19E+0002	7.19E+0002	7.19E+0002
16		7.19E+0002	7.19E+0002	7.19E+0002
15		7.18E+0002	7.18E+0002	7.18E+0002
14		7.18E+0002	7.18E+0002	7.18E+0002
13		7.18E+0002	7.18E+0002	7.18E+0002
12		7.18E+0002	7.18E+0002	7.18E+0002
11		7.17E+0002	7.17E+0002	7.17E+0002
10		7.17E+0002	7.17E+0002	7.17E+0002
9		7.17E+0002	7.17E+0002	7.17E+0002
8		7.16E+0002	7.16E+0002	7.16E+0002
7		7.16E+0002	7.16E+0002	7.16E+0002
6		7.16E+0002	7.16E+0002	7.16E+0002
5		7.15E+0002	7.15E+0002	7.15E+0002
4		7.15E+0002	7.15E+0002	7.15E+0002
3		7.15E+0002	7.15E+0002	7.15E+0002
2		7.15E+0002	7.15E+0002	7.15E+0002
1		7.14E+0002	7.15E+0002	7.15E+0002

-----  
| 49 50 51

\*\*\*\*\* End of logbook \*\*\*\*\*

B

## EXTRACTION WELL DEVELOPMENT

# MONTGOMERY WATSON AMERICAS, INC.

## FIELD SAMPLING AND TESTING SOPs AND TGDs

Section Well Installation and Testing	Section No. 208	Date of Issue June 1994	Reviewed By T. Karwoski
Subject Extraction Well Development	Page of 1 4	Date Revised June 1995	Authorized By K. Quinn

**Scope and Application:** This SOP is for the initial development of extraction wells.

**References:** Groundwater and Wells (Driscoll, 1986).

### **Procedures**

The general procedure for effective development is:

- Begin surging the well with a surge block until sediment production goes down.
- Go to air jetting.
- Go back to surge block or pumping.
- Alternate between surge block, pumping, and jetting.
- Finish by pumping.
- Check and record specific capacity (pumping rate/drawdown in gpm/ft).

The specific procedure for development is:

1. Before beginning development drop a bailer to the bottom of the well and then pump it (quickly raise and lower) to check for sediment. If the well bottom or sump is full of sediment, remove it before starting development (e.g. use a pump installed into the sump or use a bailer).
2. Retain a sample of water and sediment removed from the bottom of the screen. This will be used to document the size fraction of material in the well before development. If development results in breaking the screen (e.g. dropping a string of tools to the bottom, breaking a weld on the base, etc.). allowing coarser grained sediment to come in, this sample would document this coarse grain size was not present before development.

**MONTGOMERY WATSON AMERICAS, INC.**

**FIELD SAMPLING AND TESTING SOPs AND TGDs**

Section Well Installation and Testing	Section No. 208	Date of Issue June 1994	Reviewed By T. Karwoski
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3. Start development with a valved surge block to remove the fines in the immediate vicinity of the screen. The surge block gasket should fit firmly in the well (no space between well casing and gasket, but not so tight to be too difficult to remove or cause damage to the well). The valve on the surge block should be closed for wells in high permeability sand and gravel. This will allow water and sediment to move upward through the block, but not downward.

However, in lower permeability soils, opening the valve may be required to allow moving the surge block.

**Surge Block Operation:**

- Use of a rig with a hydraulic head is more effective with a surge block than with a cable tool rig where the weight of the rod and string only forces the tool down.
- Drillers must check and mark on the rig, the point where the top of the drill rod would put the surge block at the bottom of the well screen.
- Do not lower the surge block into the casing sump below the screen unless the valve is opened or the gasket is loose enough to allow flow past it.
- Start at the bottom of the well screen, raising and lowering the surge block in approximately 2 ft strokes.
- The surging should pull water and sediment into the well on the upstroke. On the downstroke, some sediment and water is forced up through the check valve and some is forced out of the screen. This action loosens the sediment outside the screen and pulls it in on the upstroke.
- Continue operation from the bottom to the top of the screen.
- Contain sediment produced as necessary.

## MONTGOMERY WATSON AMERICAS, INC.

### FIELD SAMPLING AND TESTING SOPs AND TGDs

Section Well Installation and Testing	Section No. 208	Date of Issue June 1994	Reviewed By T. Karwoski
Subject Extraction Well Development	Page of 3 4	Date Revised June 1995	Authorized By K. Quinn

- Collect a sample of sediment once during development and once on completion to compare back to the original, pre-development sample to check for effectiveness of development and for possible screen damage. Note on development form:
  - Grain size, especially note any grains coarser than installed screen size.
  - Color, especially any black or gray bacterial matter (generally only on wells being re-developed).
- 4. Surging should be followed by air jetting. A jetting tool typically consists of a set of horizontal nozzles, slightly smaller than the well diameter. A dual tube arrangement is available from some contractors that allows jetting through the nozzles or to act as an air lift pump when redirecting the air up the center tube. However, air lift pumping requires approximately 40% to 60% submergence (i.e.(depth below water/total depth)\*100) which we typically do not have, except in very shallow groundwater conditions. Pumping at <40% submergence is possible but air is also blown out the bottom of the dual tube.

#### Air Jetting Operation:

- The objective of air jetting is to apply a large force on the screen, sand pack, and formation to loosen encrustation, precipitates, and sediment for later removal.
- Because an air jet only applies force outward from the screen it is imperative that it be used with another method to pull water and sediment back into the well for removal.
- A dual tube - air jet/air lift pump can do this if submergence conditions are favorable.
- Air jetting should be started with straight air, some water can be injected later for additional force if air alone is not successful.

**MONTGOMERY WATSON AMERICAS, INC.**

**FIELD SAMPLING AND TESTING SOPs AND TGDs**

<b>Section</b>	<b>Well Installation and Testing</b>	<b>Section No.</b>	<b>Date of Issue</b>	<b>Reviewed By</b>
		208	June 1994	T. Karwoski
<b>Subject</b>	<b>Extraction Well Development</b>	<b>Page of</b>	<b>Date Revised</b>	<b>Authorized By</b>
		4 4	June 1995	K. Quinn

- Jet each zone of the screen while rotating the nozzles to get full coverage.
- Alternate between jetting and pumping as often as practical but do not jet for more than 3 minutes per foot of screen without pumping.
- After jetting a zone, pump as soon as possible but not more than one hour after jetting.

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20023601/203

# C

## AIR STRIPPER GENERAL SPECIFICATIONS

**AIR STRIPPING TOWER GENERAL  
SPECIFICATIONS**

**TABLE C-1**  
**Estimated Extracted Groundwater Influent Concentrations and Effluent Standards**  
**Beloit Corporation - Blackhawk Facility**  
**Rockton, Illinois**

Analyte	Groundwater Extraction System Estimated Influent Quality				
	EW01 <sup>(1)</sup>	EW02 <sup>(2)</sup>	EW03 <sup>(3)</sup>	EW04 <sup>(4)</sup>	TOTAL <sup>(5)</sup>
<b>VOCs (ug/L)</b>					
Carbon disulfide	ND [4]	ND [1]	ND [6]	ND [2]	0
Chloromethane	ND [4]	ND [1]	ND [6]	ND [2]	0
1,1-Dichloroethane	ND [4]	ND [1]	2 [6]	ND [2]	1
1,2-Dichloroethane	80 [4]	ND [1]	ND [6]	ND [2]	20
1,1-Dichloroethene	ND [4]	ND [1]	2 [6]	2 [2]	1
1,2-Dichloroethene	120 [4]	ND [1]	1 [6]	ND [2]	30
Tetrachloroethene	2,468 [4]	130 [1]	12 [6]	ND [2]	653
1,1,1-Trichloroethane	12 [4]	18 [1]	34 [6]	33 [2]	24
Trichloroethene	23 [4]	ND [1]	3 [6]	111 [2]	34
<b>SVOCs (ug/L)</b>					
Bis(2-ethylhexyl)phthalate	ND[3]	ND [1]	ND[3]	ND [2]	0
Diethylphthalate	1 [3]	ND [1]	ND[3]	1 [2]	1
Dimethylphthalate	ND[3]	ND [1]	ND[3]	1 [2]	0
Di-n-butylphthalate	0 [3]	ND [1]	ND[3]	1 [2]	0
Phenol	ND[3]	2 [1]	ND[3]	ND [2]	1
<b>Pesticides/PCBs (ug/L)</b>					
Endrin aldehyde	ND [2]	ND [1]	ND[3]	ND [2]	0
Heptachlor	ND [2]	ND [1]	ND[3]	0 [2]	0
PCBs	--	--	--	--	--

**General Notes:**

1. ND = Analyzed, but not detected in any samples
2. -- = Not analyzed
3. Unless otherwise indicated, concentrations are for the total of a constituent.

**Footnotes:**

- (1) Estimated influent quality of groundwater extracted from EW01 was calculated as the average of groundwater samples collected from monitoring wells W23 and W23B and analyzed during the RI. Nondetected results were averaged as zero. The total number of samples averaged are indicated in brackets. The extraction rate from EW01 is 50 gpm.
- (2) Estimated influent quality of groundwater extracted from EW02 was calculated as the average of groundwater samples collected from monitoring well W41 and analyzed during the RI. Nondetected results were averaged as zero. The total number of samples averaged are indicated in brackets. The extraction rate from EW02 is 50 gpm.
- (3) Estimated influent quality of groundwater extracted from EW03 was calculated as the average of groundwater samples collected from monitoring wells W3R, W5R, and W25C and analyzed during the RI. Nondetected results were averaged as zero. The total number of samples averaged are indicated in brackets. The extraction rate from EW03 is 50 gpm.
- (4) Estimated influent quality of groundwater extracted from EW04 was calculated as the average of groundwater samples collected from monitoring well W26C and analyzed during the RI. Nondetected results were averaged as zero. The total number of samples averaged are indicated in brackets. The extraction rate from EW04 is 50 gpm.
- (5) The estimated influent quality of the combined groundwater from extraction wells EW01, EW02, EW03, and EW04 were averaged to arrive at the total estimated influent quality of the extracted groundwater from the four extraction wells.

FROM : MONTGOMERY WATSON  
JUL 26 1995 00:00

TO : MONTGOMERY WATSON  
COMMERCIAL DIVISION

1995.06-22 10:56 #894 P.03/05  
RECEIVED 10:56

## PACKED TOWER AIR STRIPPING MODEL CALCULATIONS

CARBONAIR ENVIRONMENTAL SYSTEMS  
8640 MONTICELLO LANE  
MAPLE GROVE, MN 55369  
PHONE: 612-425-2992  
FAX: 612-425-6882

TOWER DIAMETER (FT):	4.00
PACKING HEIGHT (FT):	20.00
PACKING TYPE:	3.5" TRIPACK
WATER FLOW RATE (GPM):	200.00
HYDRAULIC LOADING (GPM/SQ.FT.):	15.92
AIR-TO-WATER RATIO (UNITLESS):	50.00
AIR FLOW RATE (CFM):	1336.90
DESIGN TEMPERATURE (F):	55.00
PRESS DROP PER FOOT OF PACKING (IN):	0.06
TOTAL PRESS DROP ACROSS PACKING (IN):	1.20

COMPOUND	INFLUENT CONC. (UG/L)	EFFLUENT CONC. (UG/L)	REMOVAL EFFICIENCY (%)	OFF-GAS CONC. (UG/L)	OFF-GAS EMISSION (LBS/DAY)
1,2-DCA	20.000	2.800	86.000	0.344	0.041
1,2-DCE	30.000	0.200	99.333	0.596	0.072
PCE	653.000	2.800	99.571	13.004	1.561
1,1,1-TCA	24.000	0.100	99.583	0.478	0.057
TCE	34.000	0.200	99.412	0.676	0.081
TOTAL VOCs	761.000	6.100	99.198	15.098	1.813

FROM : MONTGOMERY WATSON  
U.S. EPA - CCR

TO : MONTGOMERY WATSON  
CARBONAIR SYSTEMS

1995.06.22 10:59 #894 P.04/05

### PACKED TOWER AIR STRIPPING MODEL CALCULATIONS

CARBONAIR ENVIRONMENTAL SYSTEMS  
8640 MONTICELLO LANE  
MAPLE GROVE, MN 55369  
PHONE: 612-425-2992  
FAX: 612-425-6882

TOWER DIAMETER (FT):	4.00
PACKING HEIGHT (FT):	20.00
PACKING TYPE:	3.5" TRIPACK
WATER FLOW RATE (GPM):	(400.00)
HYDRAULICLOADING (GPM/SQ.FT.):	31.83
AIR-TO-WATER RATIO (UNITLESS):	25.00
AIR FLOW RATE (CFM):	(1336.90)
DESIGN TEMPERATURE (F):	55.00
PRESS DROP PER FOOT OF PACKING (IN):	0.06
TOTAL PRESS DROP ACROSS PACKING (IN):	(1.20)

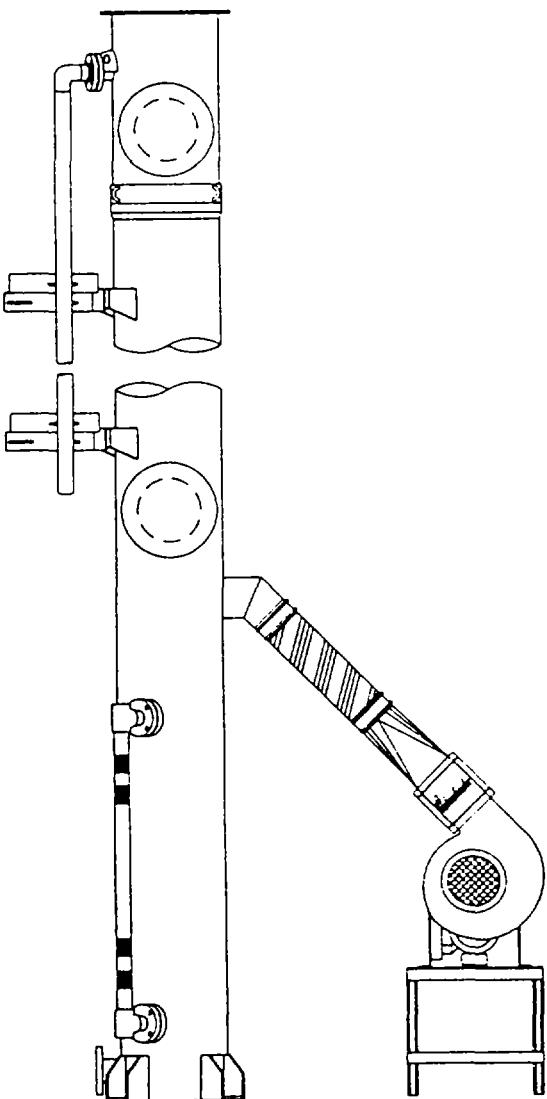
COMPOUND	INFLUENT CONC. (UG/L)	EFFLUENT CONC. (UG/L)	REMOVAL EFFICIENCY (%)	OFF-GAS CONC. (UG/L)	OFF-GAS EMISSION (LBS/DAY)
1,2-DCA	20.000	6.800	66.000	0.528	0.063
1,2-DCE	30.000	0.900	97.000	1.164	0.140
PCE	653.000	10.000	98.469	25.720	3.088
1,1,1-TCA	24.000	0.300	98.750	0.948	0.114
TCE	34.000	0.800	97.647	1.328	0.159
TOTAL VOCs	761.000	18.800	97.530	29.688	3.564

# OS Series

## Packed Column Air Strippers

Carbonair has a complete line of standard packed column air strippers. These units can be built according to specification or custom designed for a particular site.

The OS series packed column air strippers are forced draft air stripping columns designed to remove volatile organic compounds (VOC's) from contaminated water and can accommodate a wide range of flow rates and contaminant concentrations. The OS series are one-piece units constructed of durable fiberglass-reinforced plastic with corrosion-resistant PVC internals.



### STANDARD COMPONENTS

- External riser pipe with brackets.
- Water inlet and outlet ports.
- Air inlet and outlet ports.
- A sump drain at the base of the tower.
- Access manways for inspections and media replacement.
- Guy wire lugs for support.
- Water distribution piping.
- Mist eliminator.
- Blower and blower ducting.

### OPTIONAL COMPONENTS

- Off gas downcomer ducting and brackets.
- Discharge pump and piping.
- Level control assembly.
- Guy wire kit.
- Carbon steel or aluminum construction.

### SPECIFICATIONS

Listed on reverse.



**CARBONAIR®**  
ENVIRONMENTAL SYSTEMS

8640 Monticello Lane  
Maple Grove, MN 55369-4547  
612-425-2992 800-526-4999  
Fax 612-425-6882

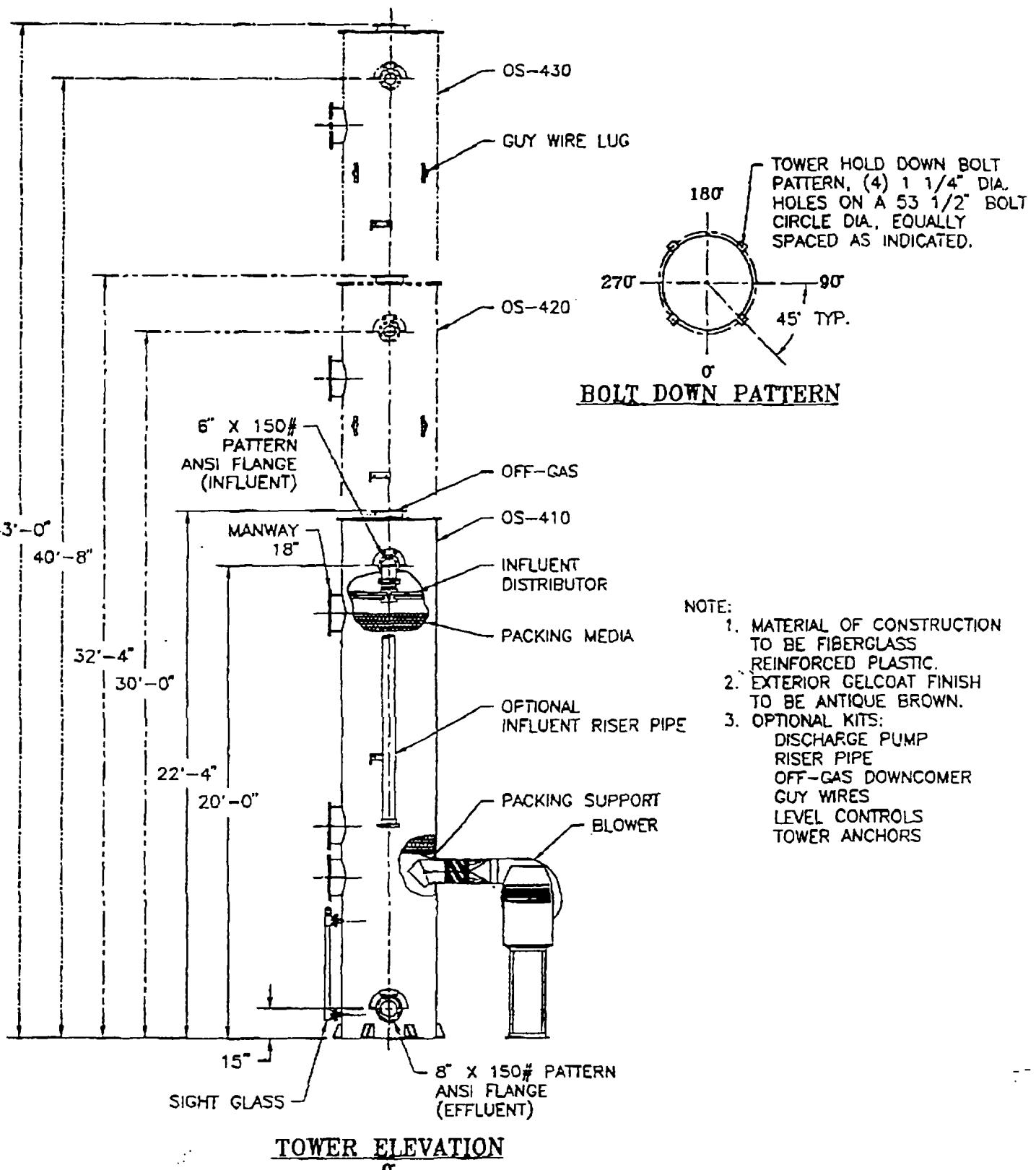
## SPECIFICATIONS

	MODEL S	05-100	05-200	05-300	05-400	05-500	05-600	05-800	05-1000
<b>TOWER DIAMETER (ft)</b>									
LIQUID FLOW RANGE (gpm) <sup>1</sup>	1 - 80	5 - 200	10 - 420	25 - 750	40 - 1,200	60 - 1,700	100 - 3,000	160 - 4,700	
NOMINAL LIQUID FLOW (gpm) <sup>1</sup>	30	60	140	250	390	570	1,010	1,570	
NOMINAL AIR FLOW RATE (cfm) <sup>1</sup>	200	400	940	1,670	2,610	3,810	6,750	10,500	
STANDARD BLOWER HEAD @ 10' w.c. <sup>2</sup>	14	2	5	7' <sup>3</sup>	7' <sup>4</sup>	10	15	20	
STANDARD PACKING	1-Inch	2-Inch	2 Inch	3 <sup>1</sup> / <sub>2</sub> -Inch					
PACKING VOLUME (ft <sup>3</sup> /10 ft section)	14	31	71	126	196	283	503	785	
<b>OVERALL HEIGHT (ft)<sup>5</sup></b>									
10 Feet of Packing	20	20	20	20	21	21	22	22	
20 Feet of Packing	30	30	30	30	31	31	32	32	
30 Feet of Packing	42	42	42	42	43	43	44	44	
<b>EMPTY WEIGHT (lbs)<sup>6</sup></b>									
10 Feet of Packing	271	466	708	1,309	1,765	2,274	3,893	5,385	
20 Feet of Packing	407	730	1,292	2,076	2,854	3,735	6,430	9,077	
30 Feet of Packing	562	1,020	1,825	2,913	4,031	5,302	9,145	12,990	
<b>OPERATING WEIGHT (lbs)<sup>7</sup></b>									
10 Feet of Packing	618	1,784	3,763	6,460	9,815	13,859	25,377	37,577	
20 Feet of Packing	807	2,193	4,583	7,683	11,617	16,345	28,853	44,119	
30 Feet of Packing	1,015	2,628	5,143	11,711	13,507	18,937	33,391	50,881	
<b>PIPING SIZE (inches)<sup>8</sup></b>									
Water Inlet Pipe	2 <sup>1</sup> / <sub>2</sub>	3	4	6	6	8	10	10	
Water Outlet Pipe	4	4	6	8	8	10	12	12	
Air Outlet Pipe	6	8	10	12	16	18	22	25	
FOOT-PRINT AREA (ft <sup>2</sup> )	3	7	13	20	28	38	64	95	

### NOTES

- The nominal liquid flow rates are based on a hydraulic head of 20 gpm/ft which yields a pressure drop across the packing of <0.1 inHg of packing at nominal air flow rates.
- The nominal air flow rates are based on an air-to-water ratio of 50:1.
- The standard blower horse powers are based on the corresponding nominal flow rates and on the assumption that the air outlets are open to the atmosphere.
- The overall height estimate includes a one-piece tower containing a sump, packing media supporting material, packing media, distribution system, demising media, and air outlet pipe.
- The empty weight estimate includes the FRP tower and packing media.
- The operating weight estimate includes the FRP tower, packing media, liquid hold-up on the packing media (assuming 10% of packing section volume), and liquid hold-up in the sump (assuming a liquid height of 6 feet).
- The water and air pipe sizing is based on nominal flow rates.

Air Stripper  
OS-410, OS-420, OS-430



ALL OS-SERIES AIRSTRIPPERS ARE CUSTOM MADE  
TO MEET YOUR PROJECT SPECIFICATIONS. ACTUAL  
DIMENSIONS MAY VARY DEPENDING ON PROJECT NEED.

Sales Drawing #140748  
95.04.03  
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# **LOW PROFILE AIR STRIPPER GENERAL SPECIFICATIONS**

Carbonair Environmental Systems  
 8640 Monticello Lane  
 Maple Grove, MN 55369  
 612-425-2992 800-526-4999  
 Fax: 612-425-6882

06/30/95  
 10:22:34

-----STAT 180-----  
 VERSION 2.4

WATER FLOW RATE: 200.0 gpm  
 AIR FLOW RATE: 700.0 cfm  
 WATER TEMPERATURE: 55.0 F  
 AIR-TO-WATER RATIO: 26:1

Influent Conc. for 1,2-DICHLOROETHANE 20.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	29.01211	14.1976	0.2232	0.0139
2	45.46765	10.9065	0.3498	0.0218
3	56.06146	8.7877	0.4312	0.0269
4	63.44724	7.3106	0.4881	0.0305
5	68.88691	6.2226	0.5299	0.0331
6	73.05727	5.3885	0.5620	0.0351

Influent Conc. for TRANS-1,2-DICHLOROETHENE 30.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	56.80326	12.9590	0.6554	0.0409
2	80.05194	5.9844	0.9237	0.0577
3	90.52016	2.8440	1.0445	0.0652
4	95.43515	1.3695	1.1012	0.0687
5	97.78810	0.6636	1.1283	0.0704
6	98.92500	0.3225	1.1414	0.0713

Influent Conc. for TETRACHLOROETHENE 653.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	61.80628	249.4050	15.5229	0.9691
2	84.89401	98.6421	21.3215	1.3310
3	93.94506	39.5388	23.5947	1.4730
4	97.56013	15.9324	24.5026	1.5296
5	99.01475	6.4337	24.8679	1.5524
6	99.60181	2.6002	25.0154	1.5616

Influent Conc. for 1,1,1-TRICHLOROETHANE 24.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	62.79233	8.9298	0.5796	0.0362
2	85.63640	3.4473	0.7905	0.0493
3	94.37835	1.3492	0.8712	0.0544
4	97.78807	0.5309	0.9027	0.0564
5	99.12787	0.2093	0.9150	0.0571
6	99.65585	0.0826	0.9199	0.0574

Carbonair Environmental Systems  
 8640 Monticello Lane  
 Maple Grove, MN 55369  
 612-425-2992 800-526-4999  
 Fax: 612-425-6882

06/30/95  
 10:22:34

-----STAT 180-----  
 VERSION 2.4

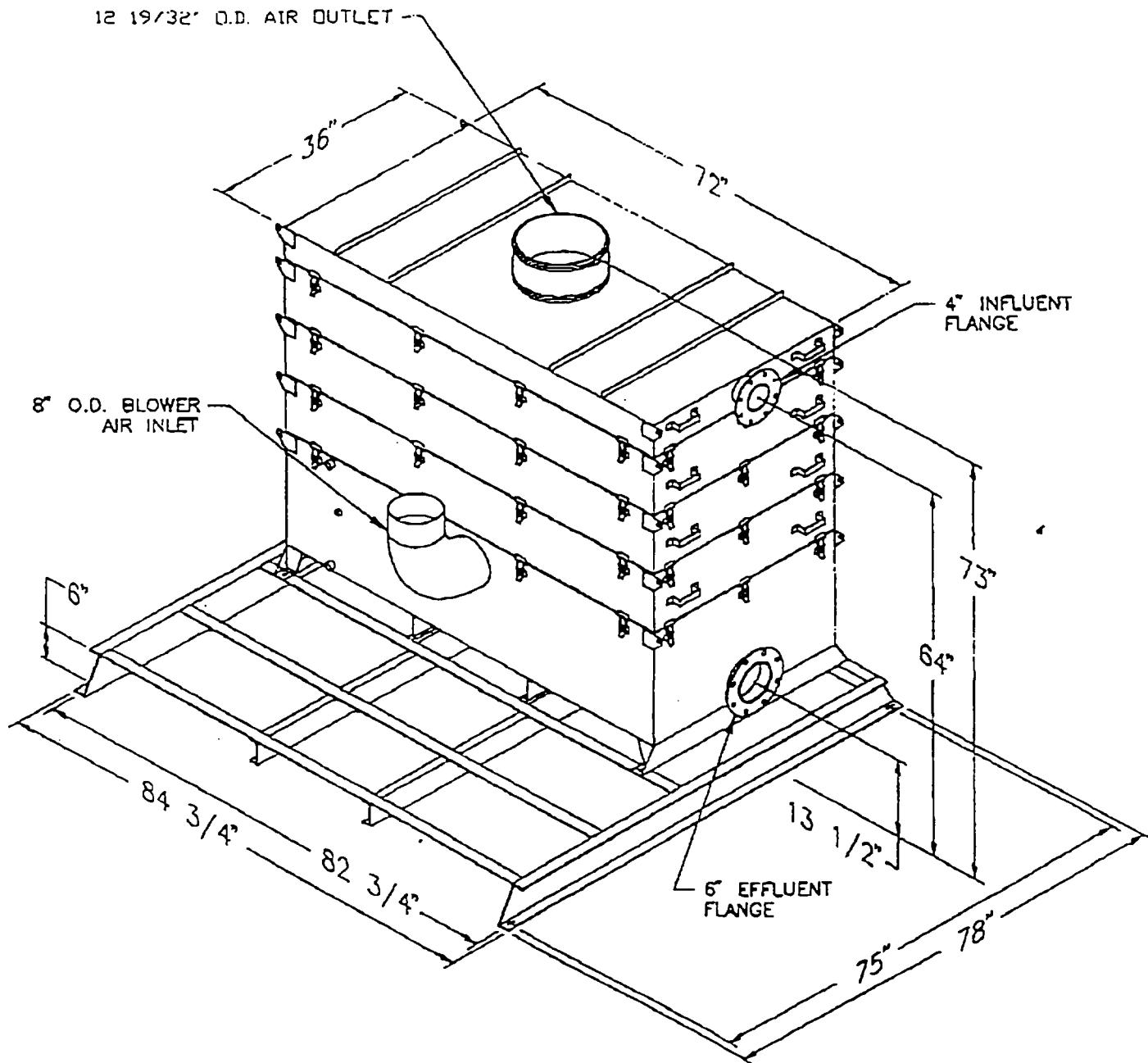
WATER FLOW RATE: 200.0 gpm  
 AIR FLOW RATE: 700.0 cfm  
 WATER TEMPERATURE: 55.0 F  
 AIR-TO-WATER RATIO: 26:1

Influent Conc. for TRICHLOROETHENE 34.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	59.06565	13.9177	0.7724	0.0482
2	82.36709	5.9952	1.0771	0.0672
3	92.24435	2.6369	1.2063	0.0753
4	96.55801	1.1703	1.2627	0.0788
5	98.46639	0.5214	1.2876	0.0804
6	99.31549	0.2327	1.2987	0.0811

Influent Conc. for TOTAL VOCs 761.0 ppb

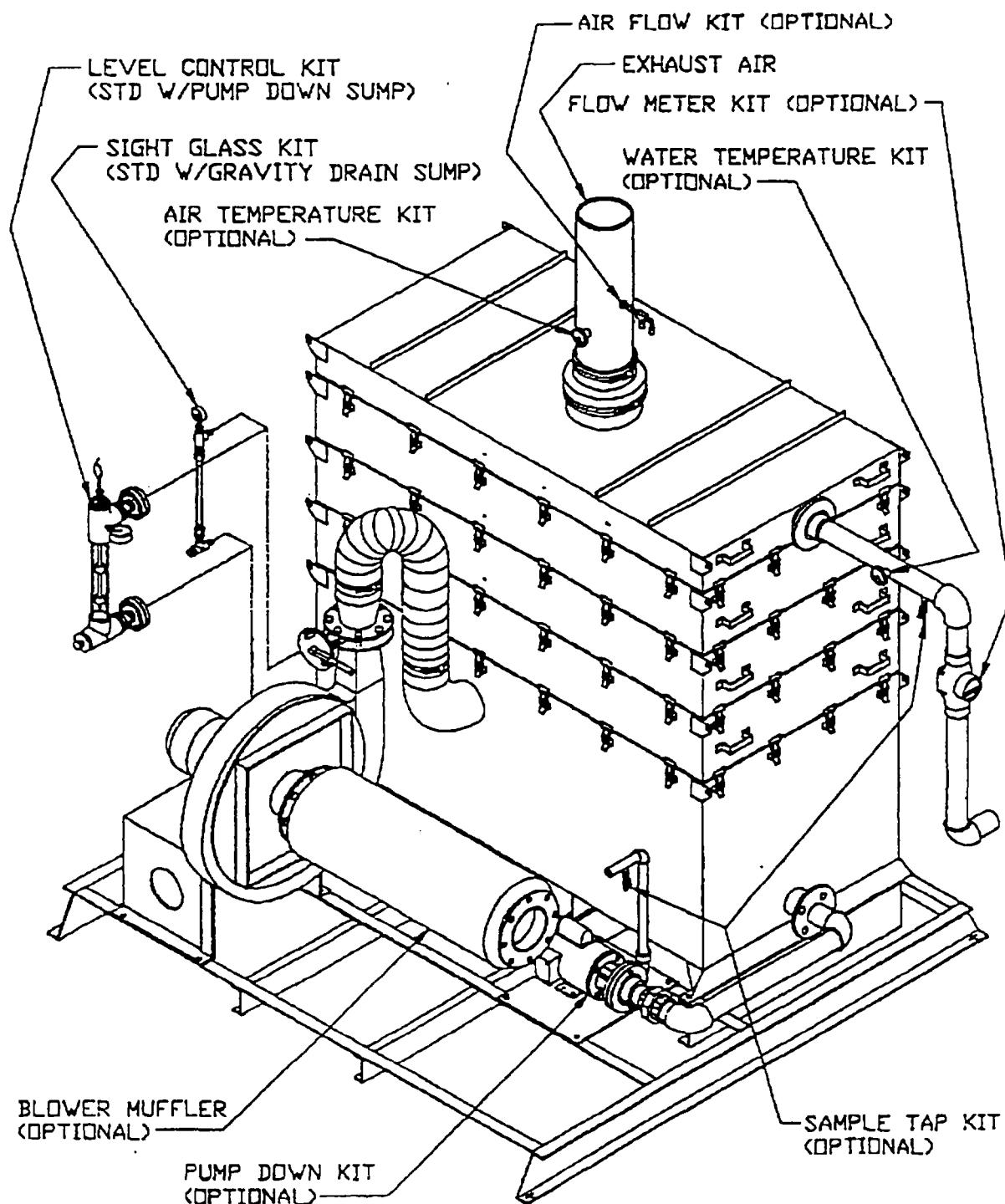
NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	60.65583	299.4091	17.7535	1.1083
2	83.57747	124.9754	24.4625	1.5271
3	92.75210	55.1566	27.1478	1.6948
4	96.54224	26.3135	28.2572	1.7640
5	98.15367	14.0506	28.7288	1.7935
6	98.86641	8.6266	28.9374	1.8065



NOTE: Adjust overall height by 10 1/4" for each aeration tray added or deleted.  
Influent flange on the same side as effluent with odd number of trays.

Sales Drawing #133583  
94.05.09  
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## STAT 180 W/ NYB &amp; OPTIONAL KITS



Sales Drawing #133542  
94.08.22

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